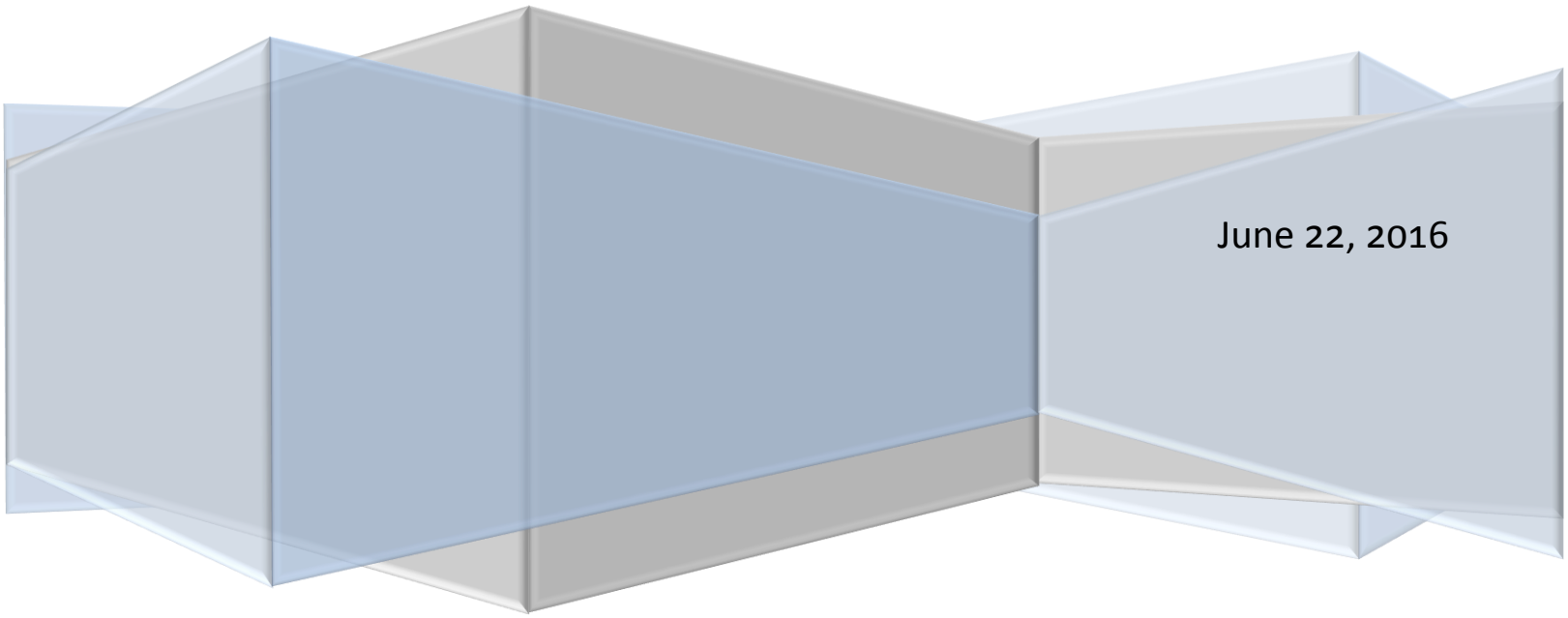
# Solar energy in the Cranbrook area

## MGMT 490

**Kyler Robertson**



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## Introduction

The initial project will focus on solar technology and its application in Cranbrook and the surrounding areas in regards to residential and small business. The question to answer in this project is “What are the stories, successes, and challenges experienced by people converting to solar energy in their homes or small businesses, and is it viable to consider solar power today in the Cranbrook area.” The scope of the project will be to have an in-depth view of the installation and economic consequences of going solar. A broader approach will be taken in the literature review for topics such as the life cycle of the solar products, including manufacturing and disposal concerns. Also, it will be important to look at how suited solar is for the area, and if it would be a beneficial project to pursue given the current type of electrical generation in the province.

This research can be important to a few different stakeholders within the area. The main stakeholders in the research project are the solar installers, BC Hydro, the College of the Rockies, and residential and small business within the community. The solar installers will be directly involved in the research process, and the results of this research has the potential to be beneficial against other competitors in the area. BC Hydro will have a key part because the research is about implementing an energy product that will be replacing the need for BC Hydro’s energy and potentially selling some of the energy back into the grid lines. The College of the Rockies is important to consider because the research is a face of the college and what the researcher does makes an impression on whoever the researcher interacts with while researching. The residential customers and small businesses will have a big part in this research because they will be examined and questioned on how they have transitioned to solar or what their thoughts on transitioning to solar are. There are even more stakeholders that can be considered

including the city of Cranbrook, producers of non-solar energy, and anyone who is involved directly or indirectly with energy.

This needs-based research project will be done to update the knowledge of the current economic position of solar energy. This will be a research-driven project as it will be finding what the current situation in the area is and will be applicable to companies dealing with solar products in a way that could be beneficial for them. If there would be a need for funding this project, it would have some similarities to activities a solar company would do anyways as part of their market research.

## Planned Partner

The plan for the project is to work with a solar panel installer in the area and work with them to understand what the payback time is for solar panels. One of the companies that could potentially partner and work with the project is Ascent Electric & Solar Ltd. They are based in Cranbrook and have been doing electrical work in the area, specializing in solar solutions to energy needs. With their experience in the industry, they could help the researcher determine how well of an investment and sustainable project solar could be. There will be a few more companies that will be contacted that are around the area. Kootenay Solar is another company that seems to be specialized in solar panel installing. These two companies will be the main ones to focus on partnering with. M&R Electrical, I D S Energie, and Prairie Battery look like electrical companies that are capable of doing solar installation but will be looked at as a contingency plan.

When discussing this research project with a company there may be a underlying issue that they would want to target that may be close to this research topic; that need could modify this project in the planning stage. Contact will be made to a few of them to see if they would be interested in partnering. The more companies that agree to partner will result in getting richer data.

Ideas considered in research include going on-site with them to see how solar is installed, using their customer database to help administer surveys with their previous customers, and do a follow up of their previous solar installations to see what the benefits are. With this information and real world data it can help determine whether solar power could be a feasible option for commercial and residential application. By working with the solar installer it might be possible to interview some of their past clients who have made their conversion to solar and ask them about their experiences, successes, and obstacles in making the transition. This can give valuable information about how the process is done in the area, compared to other areas of the world.

## Concerns

Concerns that need to be identified and anticipated can have a big effect on the research or the project as a whole. The start of the concerns is if there are no solar installers to directly work with. The two main solar companies in the area will be looked at first, then the other three electrical companies as a backup plan. If there is no support from the companies, the search will have to broaden out in distance, possibly trying to get other companies in contact only by email. This will be an important aspect that will determine if this research will be conducted. If a partner has been found, the next concern will be dealing with their previous customers. Most of the research is expected to be done by survey and will be

easier to control customer reactions through carefully crafted questions. However, there will be some field work and actual interviews conducted. This can open the door to customers having more extreme reactions, including unhappy interactions with their solar installer or system. If there are any serious problems it should be made clear that this research is done separately from the company and that any issues should be discussed with them. Also, discussing any bad news with the company will be looked at as coming from an anonymous customer (Unless otherwise specified) and only information with relevance to the research question should be discussed. If multiple companies do partner with me, there will be some more privacy issues with the data. Each company should be able to see the data that only relates to their company and the average that will be presented in the final project and presentation. Also, keeping the customers responses as anonymous will be done to ensure their privacy and confidentiality. There may be some ethical concerns with conducting research. The main concern is the privacy of the individuals and the companies. If anyone feels uncomfortable with continuing an interview or finishing the survey, they will be able to stop and have their responses omitted from the project. Some of these concerns have a low chance of happening, but it is a good idea to make these contingencies to help mitigate problems in the future.

## Literature Review

In finding out the research question about people converting to solar and how economically viable it is in the Cranbrook area, there needs to be research that considers certain aspects about solar energy itself. To determine if solar power is a sustainable energy to switch to, the process of installing, using, maintaining, and disposing solar panels is needed to be shown as sustainable as well. This also includes how the solar installers perform and if they have a commitment to sustainability. The trend in the area is

also an important consideration to determine if there is a need for solar in the area or if other forms of power generation are sufficient. For recommendation to be given from this research, the literature review will cover what the different types of solar energy systems are and what each system is best suited for. It is important to compare Cranbrook's situation and how the installing process is in other places around the world to get a better understanding of the area's circumstances. This review will help give understanding as to how sustainable it is to convert to solar energy within the Cranbrook area.

## Solar Sustainability

The main type of solar energy that will be discussed in this research is solar photovoltaic cells. This converts sunlight directly into electricity, "getting its name from the process of converting light (photons) to electricity (voltage)" (National Renewable Energy Laboratory, 2014). In relation to fossil fuel methods of generating electricity, solar energy is beneficial because it does not release pollutants and does not contribute any greenhouse gasses while it is generating electricity. This makes solar energy significantly more sustainable while it is in use. However, the solar panels that create the energy have to be manufactured, then will have to be disposed of at its end of life.

The main component in the creation of a solar panel is the solar cell. This is the part that transforms light energy into electrical energy. The most commonly used material in photovoltaic cells is based on silicon semiconductors accounting for almost 90% of 2011 sales (NREL, 2015). The resource is abundant; however "silicon-based solar cell requires a lot of energy input in its manufacturing process"; consequently the source of that energy can be from a polluting source and can determine how large the solar cell's footprint actually is (Nunez, 2014). Many of the solar cells usually have one or more rare or

precious metal such as silver, tellurium, or indium (Nunez, 2014). These limited resources can bring a sustainability problem because scarcity might make it even harder and more expensive to create solar panels in the future. Another concern is that “fabricating the panels requires caustic chemicals such as sodium hydroxide and hydrofluoric acid, and the process uses water as well as electricity, the production of which emits greenhouse gases” (Nunez, 2014). These issues can make being totally environmentally friendly a challenge.

There are also other versions of the photovoltaic cell that is made with cadmium telluride instead of the silicon that is normally used. The cadmium telluride panels through their entire lifecycle generally have a smaller carbon footprint and a higher efficiency which can lead to a quicker payback time (Fthenakis, 2003). Cadmium is a carcinogenic and if improperly handled and disposed of incorrectly, has the potential to seep into ground water because of its solubility in some forms (Fthenakis, 2003). However, compared to traditional coal-burning power plants, solar could potentially release a very small amount through accidental emissions (Possibly 7g/m2 of solar panels), while coal burning power plants can produce an around 140g/GWh of cadmium as dust and air emissions (Fthenakis, 2003). One method to help mitigate the release of any toxic chemicals is to develop an effective recycling program and “would completely resolve any environmental concerns” (Fthenakis, 2003). However, a serious problem for a recycling is that there is not enough market or volume for the recycling of solar panels (Nunez, 2014). This can have solar panels heading for municipal landfills instead of being recycled. Although, there is a growing “interest in getting ahead of a swelling stream of returning panels” that can help combat the recycling problem in the future (Nunez, 2014).

## Installers Sustainability

The solar installers are a key factor in the implementation of a solar system for any person or organization wanting to convert to solar power. Based on online information, none of the potential research partners in the area have any publicly disclosed metrics on their commitment to sustainability and many do not have a strong online presence. Companies like Ascent Electric & Solar Ltd do highlight that the customer should contact them for more information regarding the solar installation process on their website. Since much of the installation for residential and small businesses comes from local contractors, there is a very limited amount of sustainability reporting. Instead, much of the sustainability reporting comes from the large manufacturers and distributers of solar panels like Sunpower in the United States and Canadian Solar. Through their sustainability reports it indicates many environmental, economic, and social metrics that the companies measure. Sunpower's sustainability report has more focus on the technology, installation, energy payback time, and supply chain (Sunpower, 2013). While Canadian Solar has a strong focus on social aspects of their company and to what extent their operations affect their employees and communities (Canadian Solar, 2014).

For a solar installer to examine these resources and their own personal experiences, it can help them decide what the best solar panels are for their customers. This will be the key deciding factor in determining how sustainable an installer actually is by their knowledge of where the product is being supplied from, and then how it is dispose of at the end of life. Many companies are deciding to produce sustainability reports to help become more transparent about their operations. However, from an annual, self-reported scorecard given out by a non-profit called the Silicon Valley Toxics Coalition (SVTC), this trend has been shown to be slowly declining and getting more opaque as more generic brand companies increase their competition and sustainability becomes less of a priority (Nunez, 2014). The

decrease of transparency along with a difference in manufacturer regulations between governments results in a harder time getting standardized data on the environmental footprint of photovoltaic panels (Nunez, 2014). It is important to note that out of 100, Sunpower scored 88, while Canadian Solar scored 14 (Silicon Valley Toxics Coalition, 2014). The significantly lower score from Canadian Solar was specifically caused by the lack of transparency when questioned by the SVTC (Wang, 2014). The SVTC is planning on developing a sustainability standard for solar panels that are similar to Leadership in Energy and Environmental Design (LEED) (Nunez, 2014). These sustainability reporting factors can make it harder for a solar installer to determine how sustainable the solar panel from a specific company is, but can make them look more creditable when they do.

## Need in the area

An important aspect in considering if solar energy is viable option for the area is to consider if it is actually needed to find a more sustainable form of energy generation. Because of British Columbia's mountainous regions, there are a lot of powerful rivers and opportunity for other renewable energy sources such as from hydroelectric dams. All of British Columbia's energy capacity from renewable resources had been determined to be at 96.1% from a recent study (Nyboer & Melton, 2014). The contribution of hydroelectric in British Columbia's energy capacity is around 66.2% while solar photovoltaic is only at 0.01% (Nyboer & Melton, 2014). This means that renewable energy is already a very large part of British Columbia's current electrical status and that hydroelectric is that main source that the electricity is coming from.

While hydroelectric is a sustainable form of energy generation it does have some drawbacks. Building a large dam to produce the amount of electricity required will cause significant changes to the landscape both upstream and downstream. Upstream, this has been known to cause problems because of its effect on the natural flow of the river. In France there have been problems with silt build-up “resulting in many species disappearing completely from the lake” (Hilton, 2011). While it is relatively safe, there is a risk of the dam breaking and causing serious damage to anything in the way of the water. With proper long term maintenance these factors should be mitigated. The construction process should also be considered because in a large scale hydroelectric project it will require a large area to store a massive amount of water. This can be a problem for land that is in the way of the water because residence can be displaced and potentially fertile farmland could be lost, similar to when the Libby Dam was built south of the East Kootenays. In contrast, solar power in residential and small businesses can be designed to incorporate onto human constructions, avoiding the need to displace people. Although solar is a strong renewable resource, British Columbia does not have as strong of a need to develop solar as other areas with fossil fuel burning plants and polluted air. However, it still would be in British Columbia’s best interest to continue their development to become totally renewable.

## Energy System

A solar energy system can come in many different styles and brands to provide energy solutions. The main types of systems are the off-grid system and an on-grid solar system that is still connected to the energy grid. The off-grid system is being completely self-sufficient without any help from the energy grid. One issue with solar is that it only produces electricity in the day time and stops operation during the night. This is an issue because “most homes have higher electricity demand in the evening or at night, so off-grid systems usually incorporate either a battery (to store energy produced during the day),

a backup source of energy (like a generator), or both" (Utah Clean Energy, n.d.). This results in the system being more complex and less flexible than on-grid systems (Utah Clean Energy, n.d.). The major sustainability issue in this system is the need for the batteries which can pose an environmental challenge. For residential and small businesses, this system is better suited for either remote locations or very self-sufficient buildings.

On-grid systems provide an added security of having electricity when it is dark or cloudy, without the need for a large investment of batteries. The on-grid system can also present the added benefit of a net metering program with BC Hydro that can put energy back in the system at a rate of 9.99 cents per kWh (BC Hydro, 2015). While this system is simple in components needed and generally more convenient in monitoring and upkeep, it does not provide protection against power outages (Utah Clean Energy, n.d.). With British Columbia's amount of renewable resources the system should be sustainable to some degree. The on-grid system would be best suited for most residential and small businesses because it would help the community run on renewable energy sources to an even larger degree. For the purpose of the research project, it will be focused on the on-grid system.

## Global Installing

In other places around the world solar can behave differently based on the climate and how efficiently the panels can generate electricity.  There are a few factors that actually make the Kootenays a good candidate for solar energy generation. The colder weather is a benefit as it can increase a solar photovoltaic panel by 0.5% every degree below 20°C, resulting in a 20% increase in the panel's performance at -20°C (Skyward Energy, n.d.). The increase elevation of the Cranbrook area is beneficial

too because the light has less atmosphere to travel through to get to the solar panel (Skyward Energy, n.d.). A study “measured the average yearly electricity production in kWh for a 1 kW-sized system (5 200W panels)” (Skyward Energy, n.d.). This compared the Kootenays with other places globally. They found that Castlegar produced 1110kWh, Nelson produced 1113 kWh, and Trail produced 1120 kWh while Berlin, Germany only produced 848kWh (Skyward Energy, n.d.). This is significant because Germany has around 50% of the world's installed solar systems (Skyward Energy, n.d.). While there were no results of Cranbrook in this study, the amount of annual sunshine for Cranbrook is around 2191 hours while Castlegar is near 1854 hours, and Berlin at 1625 hours (Current results, 2015).

These factors mean that the natural situation of the Cranbrook and East Kootenay area is supportive of solar energy. However, one significant difference between Germany and a country like the United States is the pricing of implementing a solar system. In 2012, the median install price in of a solar system was around $2.51/W in Germany, while in the United States was around $5.52/W (Seel, Barbose & Wiser, 2013). Significant reasons behind the drastic price difference is the lower customer acquisition costs for the company ($0.62/W less than US), more efficiency in their installation labour ($0.36/W lower than US), along with another large gap for other miscellaneous factors, overhead, and profits (About $1.32/W) (Seel, Barbose & Wiser, 2013). This helps show that a significant portion of the cost is because of the installer and that contractors in North America still have a large gap for improvement. It is an indication that the price of solar panels is less of a factor in determining the economic viability than the labour involved in the installation. It will be important to analyse how customers are affected by this in the East Kootenay area.

### Literature Review Conclusion

This literature review provides a background to the research question; finding the stories, successes, and challenges experienced by people converting to solar energy in their homes or small businesses, and if it is viable to consider solar power today in the Cranbrook area. It starts with looking at the solar installers in the area and how their operations can affect the sustainability of the whole project. This helps understand what people are faced with and what their options are when looking for a solar installer. Understanding the need in the area for solar can help define why people would be inclined to switch to solar. With hydroelectric being a strong energy generator in the area, people could be less incline to switch based on environmental pollution factors alone. Through further research, an analysis can be done on why people switched and if they did change based on environmental factors. The economic part of switching to a solar system is very important to consider too. By researching the solar capacities in other places around the world, a comparison can be done to the people in the East Kootenay area. This can help identify if solar is a viable option for people in the East Kootenay area. Then the researched numbers can be compared to BC Hydro's prices to determine if there is a break-even point for the consumers.

## Research Methods

To investigate the research question, the study will require questioning people within the Cranbrook area with a few different research methods. There will be a survey targeted at home or business owners in the Cranbrook area who have successfully equipped their homes or businesses to run fully or partially on solar electric power. This is to get quantitative data from people who have been through the conversion process and information about their investment and electricity use. The questions for the

survey and the other research methods are located in the appendix. This survey will have a starting question to determine if the survey taker is qualified to take this questionnaire; if they own a home or business that is powered fully or partially on solar electric power. Also, asking what town they live in or where their business that uses solar energy is in will help ensure that it is within the Cranbrook area, or an area that is environmentally similar. These questions will help ensure that the target audience fills out the survey. The survey will ask the participant about their experiences with their installer to help get a quantifiable estimate of how their experience was. This will be used in conjunction with planned interviews. If there is more than one solar installer that partners with this project, there will be a question to differentiate the two and give the installers their own separate results. One of the most important questions to know is how much their establishment consumes electricity in kWh based on their most recent electrical bill when connected to the energy grid prior to using solar. And after, this question will be the basis to determine if solar power is economically viable, if there will be a break-even point on their solar investment, and if it is cheaper to stay off the electrical grid. It is also important to get the kWh as it can be compared with today's prices instead of historic prices.

The second survey will be to quantify consumers' feelings and beliefs about solar energy prior to converting their homes or businesses to solar. It will focus on the same demographic, targeting home or business owners in the Cranbrook area that do not use solar energy to power their homes or businesses. It is intended that the participants will answer based on their current feeling and beliefs and will not spend time researching each topic before answering the questions. This is to try and determine what people think before they start committing to a solar investment. The same starting question will determine if they are in the target audience, however, there are no specific questions that require them to be a home or business owner and this does not necessarily disqualify them from answering. Instead it

can see if there is a significant difference in the beliefs of home or business owners and that of the other group. The same geographical question will be asked to help keep the results within the same area; this can disqualify some participants from answering. Understanding what participants know about their own area is important and questions will be asked regarding where they think the energy comes from to power their homes or businesses along with determining how sunny they think the area is. This can be useful in determining any underlying causes that may prevent people from switching to solar energy. Another important issue is the cost of going solar and peoples' general impression on the price of solar; the interviews will help determine if their assumptions are true or not. This can be expanded upon to understand how long the participant will think it would take to reach a break-even point. A question will ask participants if they have considered switching to solar and when they would be considering it, if at all. Also, there will be a question to ask participants if they have heard of the installers in the area. The last two questions will help give an idea if people are considering switching and will be beneficial for the solar installers by giving them some brand awareness in the process.

Third there will be some interviews done to acquire some qualitative data and be more open ended to help enhance the survey research. This will be targeting people who have successfully equipped their homes or businesses to run fully or partially on solar electric power. The objective of this is to understand the stories, successes, and challenges experienced by people converting to solar energy in their homes or small businesses. It is expected that there will be some guideline questions and that the questions may deviate somewhat as natural conversation progresses and looks deeper into each question. There will be questions focusing on challenges, benefits, any surprises to see how the process had been for them. It will be important to understand why they converted in the first place and concerns they had when starting and help link the survey on peoples' feelings and believes about solar

energy in the area. The research will also look into if having solar has changed any day to day life in any significant way. Notes will be taken during the interview, and with the participant's consent the interview will be recorded to help keep the data intact. These questions can help give a view into the process of installing solar and can help fill in any gaps that are unanswered by the surveys.

## Rationale

These methods will answer the research question fully and work with each other to build a clear path on the process and outcomes of converting to solar energy. The first survey will gain a quantifiable understanding of how the process felt to them and who they worked with to install their system. It will obtain the most important question about how much power they were consuming at their home or business. It will be most effective through survey because it can be given out to the solar installers to their previous clients and possibly reach a wider audience. The second survey will pursue a larger audience and try to understand how people feel about solar energy before they start investing into it. This method is best done through survey because it is looking for a larger number of participants and is trying to quantify their feelings. It can help determine if there are any hurtles that people may have based on any assumptions. Interviews will help compare and see if any hurtles are actually justified. The in-person interviews are done to get a deeper understanding of the solar installation process and if there are any important details that the surveys could have missed. The culmination of these research methods will answer the research question fully and develop a strong framework of understanding for anyone who is considering converting to solar.

## Implementation

Actually garnering the data will require several different methods of implementation to ensure that they are adequately presented and brought into awareness of the targeted audience. Both of the surveys will be done online through Survey Monkey as a way to reach a larger audience and be more environmentally friendly. However, paper versions could still be printed and data entered manually if needed. Each of the surveys will have a preamble in the beginning to identify the purpose of the research, any privacy issues, and who the research is being conducted by. The research campaign will last for approximately a month and is estimated to start in February. These surveys will be answered anonymously so that specific questions like their kWh usage will not be tied directly to the participant. The specific kWh question may be too probing but is necessary to get an accurate number for the research.

The survey targeting people who have already converted to some form of solar power will be identified through the solar installer and handed out by them if possible through a link preferably or paper if needed. They will be able to look over the survey and approve it for distributing or make recommendations for improvement. If there are multiple solar installers who have partnered with this project, each of them will be given their separate results along with the average that will be used in the final presentation. The second survey will be given out electronically through different forms such as Facebook, or physically through a public area such as the mall or college. The appropriate candidates for the survey will be screened through the survey questions. Also, each installer will have to give consent to have their name on the question about if people have heard about them.

The Interview with the solar installer's previous customers will be conducted face to face with the participants. The people who will be interviewed will be asked through the company as an intermediary. This will be done in a session that is less than an hour long and done throughout January to March. Before the interview starts the participant will sign a letter of consent to ensure they agree to the interview and its methods. A participant will be able to leave the interview at any time in case they feel uncomfortable. An audio recording and notes of the interview will be taken if the participant gives consent and will be subsequently destroyed upon completion of the project. The interviews will be fewer in number than the surveys but will be looking for three to five in total. The results from each interview will be analyzed and presented in a way appropriate for this research.

## Expected Outcomes and Application

The main reason for this research will be to determine the breakeven point on a solar investment and how long it will take with current technology for a small company or residence. This data can give some perspective and show how solar energy is priced relative to the power grid and how viable it is for a residence or small business. Through the research it will also give the company some current information on the market from a third-party perspective that may be of use. The research will also be dedicated to examining how sustainable solar energy is and if it is one of the best choices available on the market for sources of energy.

The application for the completed research will be to help businesses and residential owners make a decision whether solar energy can be beneficial to them. The project can serve as an overview of what

solar energy's current position in the energy market is, as well as a guide that goes through the steps involved in a transition to solar power. The company that will be worked with will be able to use the data to see how consumers feel, resulting in them being able to make updates to their business strategies to suit the current market better if they desire. Other small business or residential owners who are thinking of transitioning to solar power can get recommendations from the research that can help them through the process. By offering some tips and an overview of the process, it could make people more inclined to switch.

The expected outcome of this project is to be able to make a thorough investigation on solar energy in the area. It is anticipated that solar energy is a competitive alternative to the energy grid, enough so that the transition to solar energy would pay itself back within a reasonable time frame. If it is not, it will give a realistic prediction of when it will become a better choice than the energy sources currently on the market and to what extent. The question regarding how sustainable solar energy actually is will be expected to be shown as a good choice compared to other fuel burning activities and at least equal to other alternative sustainable energy sources.

## Budget and Timeline

For the research to be completed by mid-April the research and the analysis will have to be done during that time. There are no real expenses for this research, but any travel expenses that may occur driving back and forth suggest the project will be under $100 of personal funds. The timeline is described in the Gantt chart below. January will be to get the solar installers partnered with the project and to resolve any issues. Also, it will be used to finalize the surveys online and through the solar installer. By February

the surveys should be able to be given to prospective individuals and operate until enough data has been garnered. The finish date for the surveys should be in the middle of March to give enough time for proper collection of data. During this time people will have to be made aware of the surveys and the researcher will be focused on that. If there has been any response from participants to have an interview it will be planned to happen while the surveys are running or when convenient. The rest of the semester will be dedicated to a final write-up of the project and preparation for the final presentation.

| Activity | January | | | | | February | | | | March | | | | April | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2nd | 9th | 16th | 23rd | 30th | 6th | 13th | 20th | 27th | 6th | 13th | 20th | 27th | 3rd | 10th | 17th |
| Contacting Solar Installers | | | | | | | | | | | | | | | | |
| Finalize Surveys | | | | | | | | | | | | | | | | |
| Deploy Surverys | | | | | | | | | | | | | | | | |
| Interviews | | | | | | | | | | | | | | | | |
| Analyse Data | | | | | | | | | | | | | | | | |
| Produce Final Report | | | | | | | | | | | | | | | | |

# Findings

## Interview 1 – Jori Adank

There was an interview conducted with Jori Adank, who was in the solar industry for a few decades and now is living in the Kimberley area with solar panels powering his home. Consent forms were signed to allow this interview to take place in an ethical manner. Taking a tour through his home showed that it was built from the ground up to be more efficient and better for the environment. There were two types of solar systems on the house; a thermal solar system that heated a large water tank for domestic use, and a solar PV system which is the focus of this research. The solar system that he currently has is a 5kW system and he estimates that the total cost for a system of that size would cost $17,000 to purchase and install. Through calculating the information, it shows that at the time of construction the system would cost $3.40 per Watt to purchase and install on his home.

He mentioned that some of the biggest benefits to going solar can be from not having any energy or gas bills because his entire home was built to run off solar. However, it was noted that there was a small $12 BC Hydro meter and transmission fee associated with having the energy grid connected to his house.

This set up is the on-grid system that allows energy to be used in the home like normal even at night or on days where it is cloudy and avoids the need for batteries. The picture shows how the PV solar system is arranged on the left side, along with thermal solar system in the middle. More solar panels wrapped around the lower part of the house in a similar style.

Some of the biggest challenges that he faced were the initial buying process and getting the solar system approved. This was done by getting approval from local government and BC Hydro. To get the system online and feeding back into the grid, he had to apply for net metering. Net metering allowed him to take energy off the grid when he needed and then feed some back when his solar panel were producing more than he was using. At the end of the year the net amount would be calculated and he would receive a cash credit for the amount given back or an amount that he still owed. Furthermore, this made sure that it was appropriate to construct the system and to install the necessary equipment to ensure that it is safe for everyone. It is made safe by ensuring that the power feeding into the electrical grid is

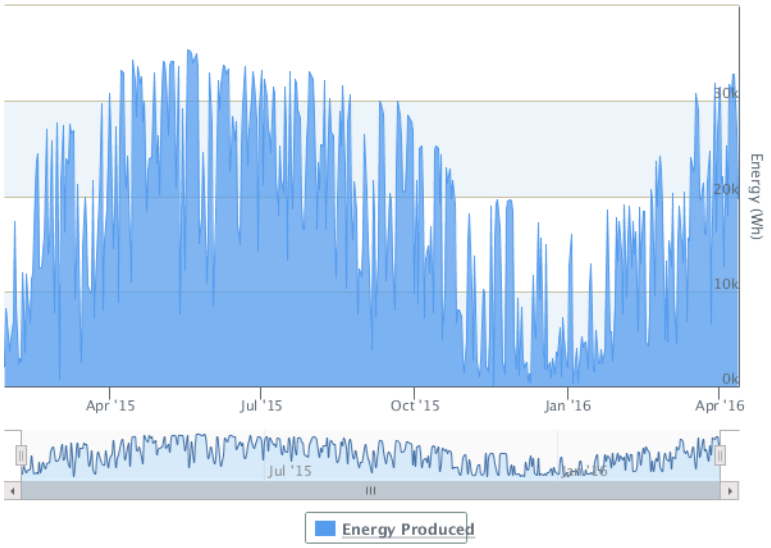
shut off during a power outage or maintenance, to prevent electrical workers from working on a live system when they think it is off. These were very small challenges for him because he was already experienced in the installation of solar equipment and because there is virtually no maintenance required for the system; it only requires a small bit of dusting off or shovelling snow a few times in the year. His solar thermal system was a larger use of time because it needed some more attention to operate properly.

There were several reasons why he chose solar energy as a large part of the house's energy. This was because it is essentially clean and free to use once installed and operating. Compared to many alternatives, the manufacturing process was not as big of a concern because there would still be the same or even more of a footprint from other forms of manufacturing.

Since he was quite experienced with solar systems already, he didn't have any real concerns about doing a solar project on his house. Instead he explained what other people generally felt were the biggest concerns when going into a solar project. The biggest issue was the seed of doubt that sprouted up to stop people from even considering switching. There were several popular concerns that increased doubt and they were addressed with appropriate answers.  What happens when the sun wasn't shining is an important issue than can be circumvented by having an on-grid system to ensure that a home still has electrical power when there is limited sun. Financing was another big issue and people presumed that they did not have the finances and were too poor to switch. Ways to overcome this problem and afford a system could be through specific green loans that banks like Toronto Dominion offer. Using the solar system as an example, if the system cost $17,000 and is expected to last 30 years, the amount of use per month could be calculated at $47.22. Another key concern that people have is wondering what the

return on investment was going to be. He mentioned that people were concerned about the return on investment being around 20 to 30 years and that it is much more than people are willing to wait; with less than 10 years being more appealing.

Methods to reduce the amount of surprises that arise from the solar project involved an experienced team and building his house from the ground up while being heavily focused and designed around energy efficiency. However, during the 2015 winter months there was a bit of a surprise when there was a significant amount of clouds that made it hard to get any energy. This shows that weather can still be an issue if it doesn't cooperate. However, still being tied into the electrical grid kept electricity working in his house. The picture shows the trend throughout the year where the higher spot is during summer and the shallower dip is the winter. The days where there are no peaks are when it has clouded over and no energy could be harvested.




There were not any significant day to day changes in activities that happen with the solar PV system. He did become a bit more careful or aware of his energy use to keep his consumption lower. He can monitor his energy production by tracking several metrics to show how well it is running. This is done through a user interface accessed through his laptop which includes an accurate timeline of energy produced and a monitoring system to ensure all panels are working properly.

There were several recommendations made for someone who was going to convert to solar during the interview. Solar PV would be the best choice overall for general electricity use and solar thermal would come in as a good second choice because when it involved any hot water use it is very cost effective. For the actual construction, it would be better to have a contractor do the installation so that they can bring their knowledge and experience into the project, and avoid costly do-it-yourself trial and errors. The best way to go solar would be to build and design a building from the ground up in the most efficient way possible. The building would ideally be placed somewhere where the view of the sun to the south, east and west is uninterrupted. However, for most people, a new construction would be very difficult and they would have to consider implementing more efficient methods into an already existing building. However, if people are looking for energy savings as a key reason to get solar it would be prudent to minimize energy use and go after some low hanging fruit first before even considering solar; changing the lighting into LED or CFL bulbs, putting in more insulation, getting more energy efficient appliances. This would be less of an investment and a great starting point for someone who wants to be more energy conscious. Also, a person should not be focused on a large system if they are not financially ready for it; if they want to start they should go with what they can afford.

This interview was a great starting point in collecting data and getting many pieces of information that will help in determining how solar is priced. It also gives a good understanding of the benefits and challenges that a person may face if they convert to solar, along with some considerations to acknowledge before starting on such a project. With someone who actually converted to solar, it shows that one can use it to power their home fully in the Cranbrook area. However, these numbers were not a hard receipt of the amount paid and were only an estimate cost from an ex solar installer. It does give

a generally accurate sense of what the cost is though. Also, this is the story from a solar installer and not a general consumer, so there was more experience going into the project than an average consumer would have.

## Interview 2 – Allan Knibbs

Another interview was conducted with Allan Knibbs, the Facilities Manager at the College of the Rockies. The most important thing for the research project was finding out that the size of the newly installed PV solar system at the college was 82kW. The total cost for the system was around $200,000. This calculated to about $2.44 per Watt. The system is estimated to save about 20% in energy costs totalling around $5,200 annually. This system is currently the 4th largest PV system in BC; the SunMine project in Kimberley is the largest at 1.05MW (BCSEA, 2015). This was outside the scope of the original research plan as the building had a larger commercial sized solar PV system, but is very useful in determining the wide range of possibilities. The picture shows what the solar panels look like on a portion of the College of the Rockies Cranbrook Campus's roof.

Some of the biggest benefits for the college going solar are the energy savings that will most likely increase in the future, the publicity of having a renewable energy system, and to be able to provide education about solar energy to both the public and to students. These were some of the main

reasons that the college chose solar energy, along with the fact that as a government building, they should be a point of leadership in the change to renewable sources of energy.

Conversely, some of the biggest problems were in the engineering aspects of the project. The building had to be inspected to determine if it was structurally sound enough and able to deal with problems such as wind loading. These had the potential to cancel the entire project. However, there were things that they changed, like the ballast manufacturers, because another company offered a lighter product that would reduce the weight on the roof.

There were some surprises that happened with the project and how the panels operated. Snow sheading off the panels in the winter was much faster than expected. This resulted in winter upkeep for the panel becoming less of a hassle and requiring less staff to brush them off as previously planned. There were some changes in day to day activities during the winter to make sure the panels were not covered in snow and that the inverters were clear. Other changes to day to day activities during the year include making sure that the panels were all operational through an online source. This can happen about three times a day, but could be reduced as the novelty of the system wears off or better monitoring systems are implemented.

Overall, Allan recommended that it was probably a no-brainer for residential to convert to solar and that the college might have more of their campuses switching as time goes on. More incentives can be seen in the recent 24% price increases in energy from BC Hydro throughout the next four years. These increases can be a strong driving force for changing energy use habits. For the interaction between BC

Hydro and the college, the contractors who were hired were the ones filling out the paperwork to make sure it went through properly. He recommends that for someone who is planning on converting to solar, it would be best to talk to a consultant or an expert in the field before doing it yourself. This way you can get the best help and information on what types of systems are the best to use as well as if it is going to be physically possible.

## Working with Anvil Electric

A portion of the research was found and some improvements to the research survey questions were done while working with Thomas. He runs Anvil Electric and has done solar installations in the area, including some of the work at the college. He pointed out that in BC there were actually very few solar systems; only around 400. There is another source from February of 2015 that states that 400 residential and small commercial customers are registered with BC Hydro's net-metering program to reinforce this idea (Lee, 2015). There were several details about solar systems that were collected through this partnership. The cost in 2013 of a solar system varied depending on the volume of panels that were installed and is shown in the table. Also, the average amount of kWh/kW generated in the area is between 1,200 and 1,300 (HESPV, 2015).

| Size of System | $ amount per Watt installed | Total Cost |
|---|---|---|
| 1.5kW | $5.00 | **$7,500** |
| 2.5kW | $4.50 | **$11,250** |
| 6kW | $3.50 | **$21,000** |
| 10kW | $3.25 | **$32,500** |

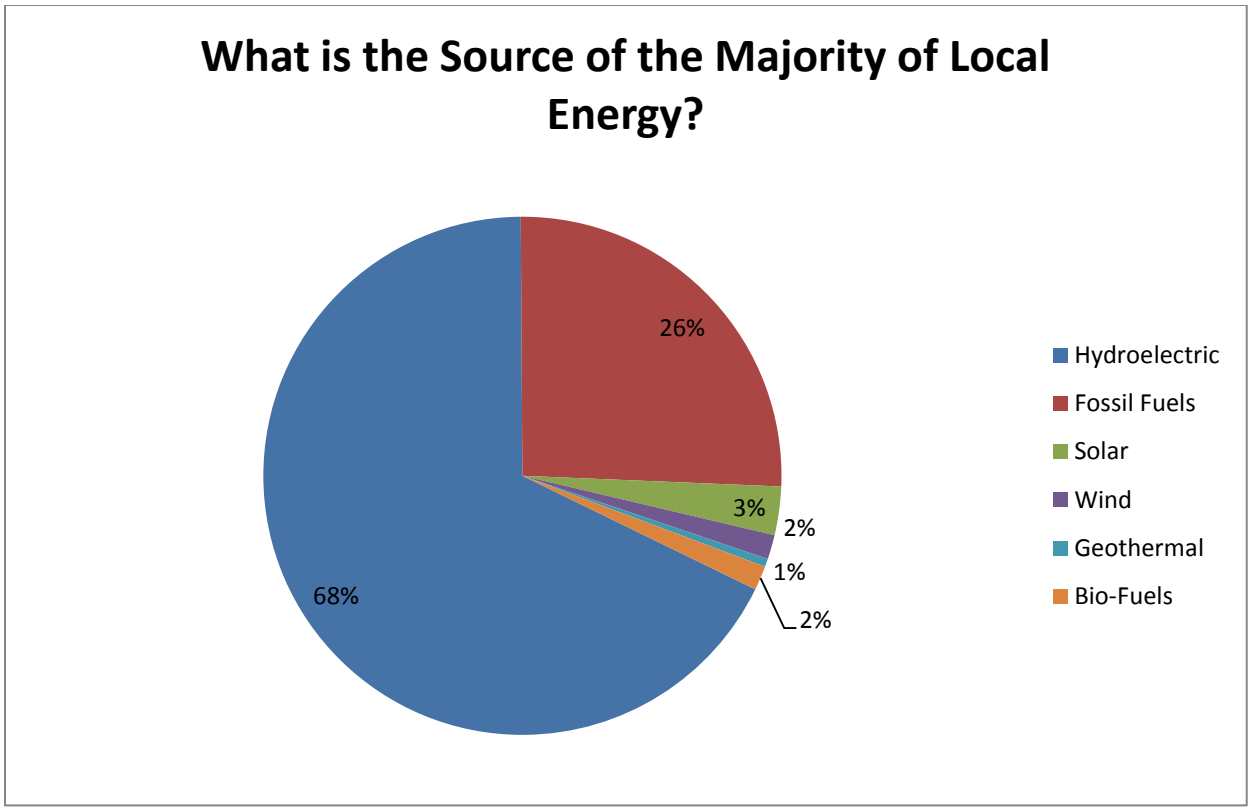
Another important variable to consider in the feasibility of the solar system is what angle the solar installation is tilted at. A report from the Canadian Government gives the PV potential at different points

of the year. For the winter months it is better to have a tilt that is at latitude +15 degrees and for the summer months it is better to have a tilt that is at latitude – 15 degrees; the transition months at March and September are better to have the tilt at latitude (Natural Resources Canada, 2016). This is to get a better angle at which to capture more of the Sun's rays.

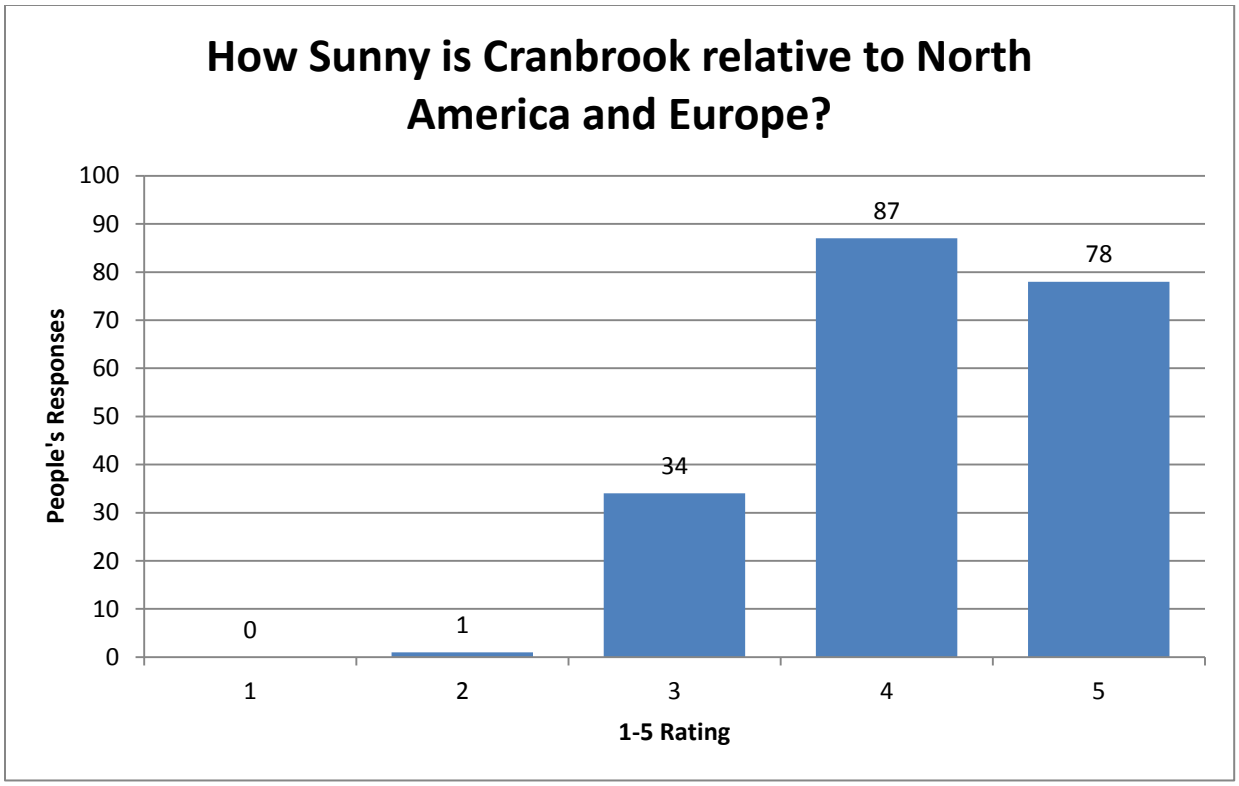
One important thing to note about this kind of data is that it will all be estimates because of the several different variables involved in measuring; like angle of the house to the south, any shade present, actual days of sun and cloud in a year, temperature, geographical area, etc. The real data would be applied on a case by case basis on each individual system and individual time period.

## Survey - General feelings and beliefs about solar

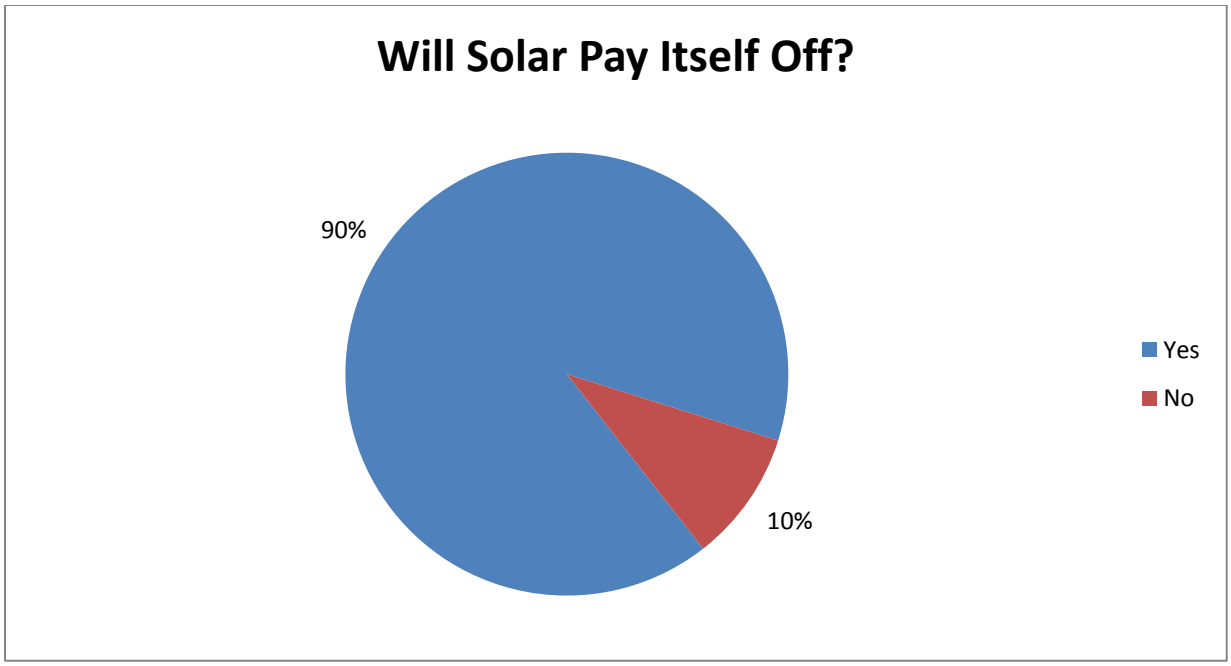
The survey was conducted over a period lasting from March 23rd to April 18th, 2016. It gathered 200 respondents in total through both online and offline methods of collecting. The online method was sent out through Facebook as planned and a few respondents were from there. The offline method consisted of going around to individuals throughout the College of the Rockies and the Tamarack Mall in Cranbrook and handing them a tablet to fill out the survey through Google Forms. This was only one of the two surveys planned that was able to be handed out to people. Several graphs were made from the data along with an analysis below, and a reference to the questions is in the Appendix.



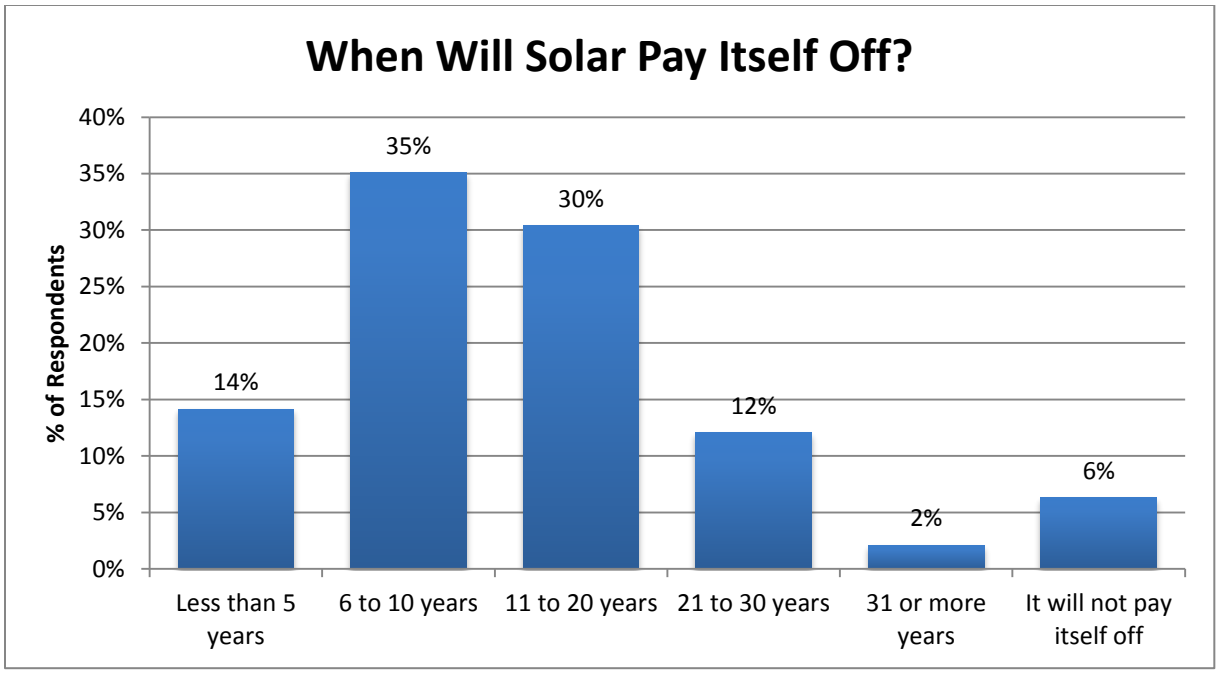

Question #1 looks at where people think the majority of energy to power their homes comes from. The correct answer for this is hydroelectric and shows that a majority of people know where their energy comes from. There is a significant part that may be confused or unaware due to several reasons. When conducting the survey some people mentioned they used fossil fuels for household heating and could misinterpret the meaning of the question. Also, there were a few individuals that said they were completely off-grid and didn't used hydroelectric anyways. There were a few responses from people outside of the East Kootenays who may have been using fossil fuels. However, this wouldn't change the data too drastically, but acknowledges that there is some error.



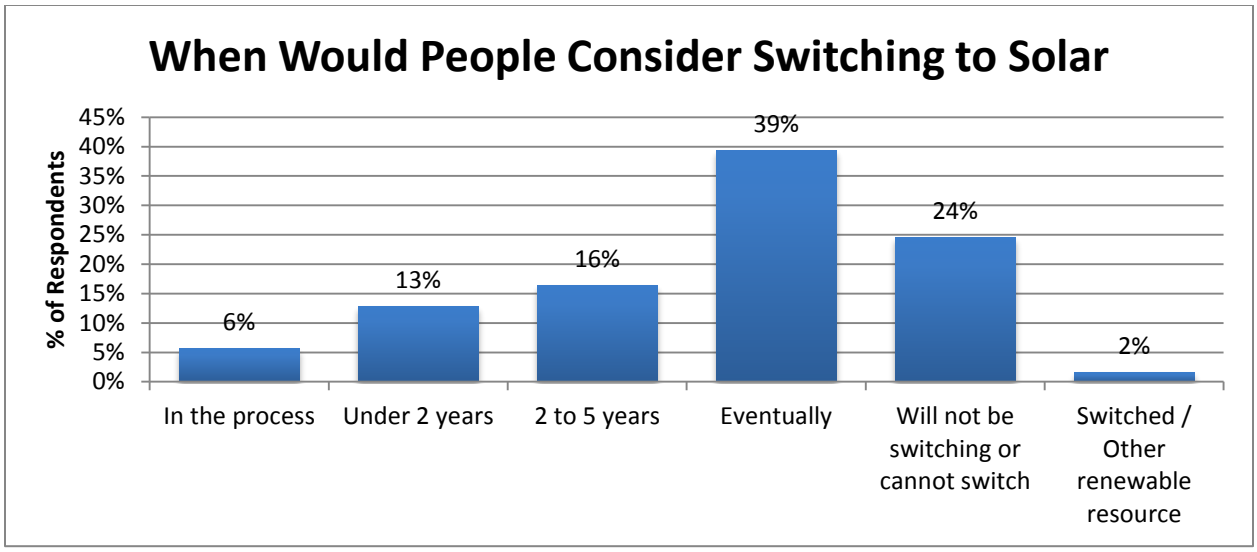

Question #2 asked people to rate how many sunny days they thought Cranbrook has in a year compared to other parts of North America and Europe. The correct answer to this was 4 to indicate that it was above average, yet below some of the most. From the answers gathered it showed that people were generally correct in their answer, with an average of 4.21. Many people mentioned the saying that Cranbrook is the sunniest place in BC when answering this question. This question gives a sense of how people in the area notice the weather and the sun outside, which could influence their decision in switching to solar power.



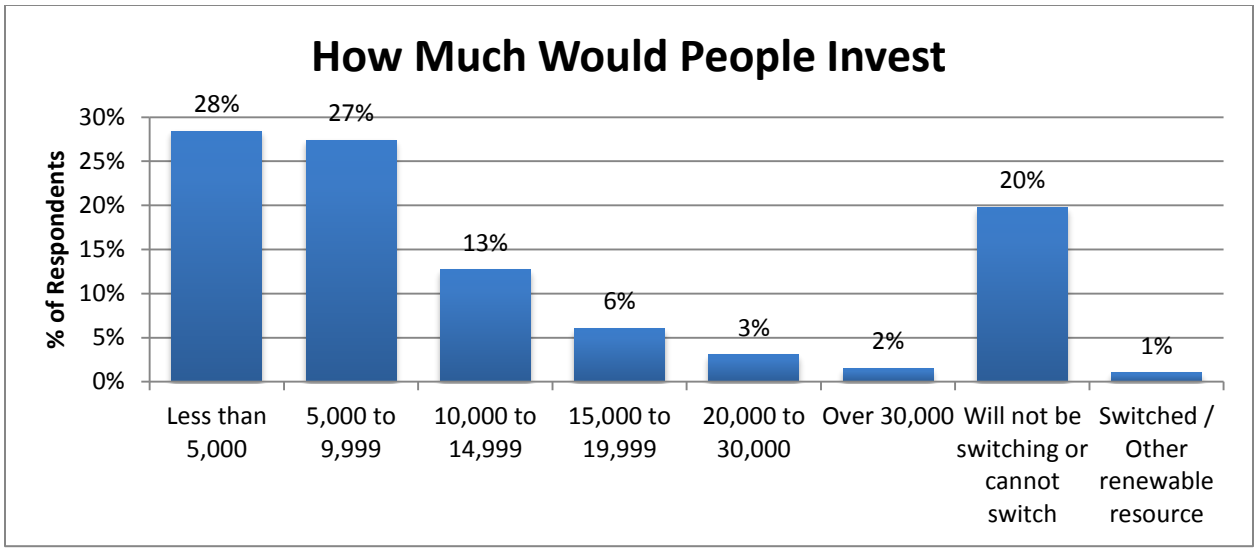

Question #3 determines if people feel that solar will pay itself off. This is a simple yes/no question to determine how confident the general public is about solar. Many people believe that solar will pay itself off at some time and the next question will go into that further.



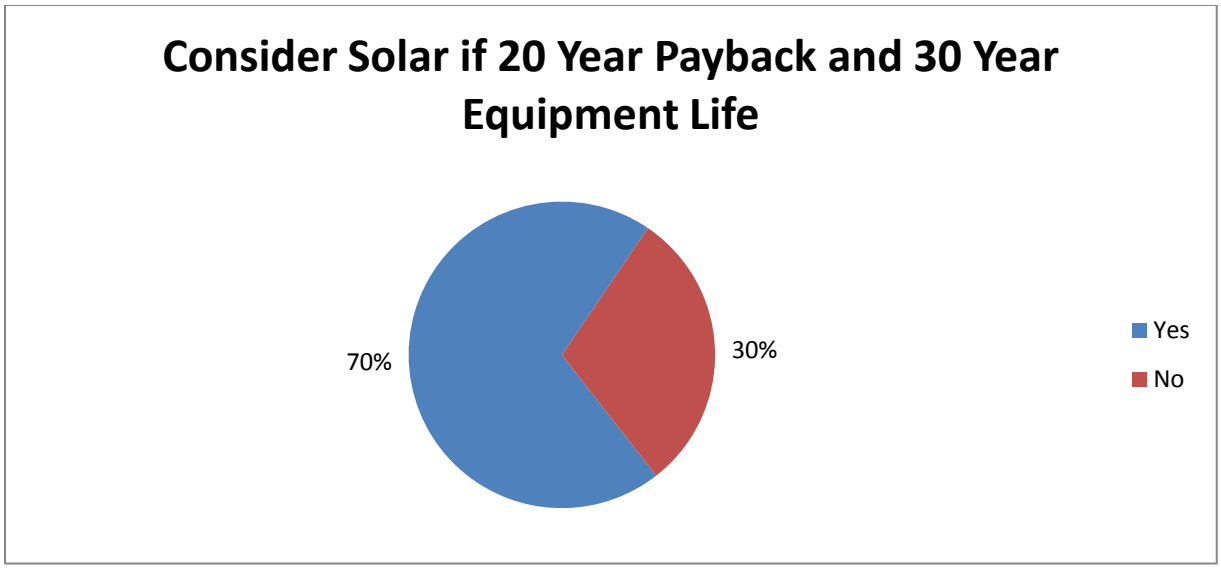

Question #4 is a follow-up to question #3 and asks when they think solar will pay itself off. An answer for this is within the high part of the 11 to 20 years and the low part of 21 to 30 years, depending on how large the solar system is and several other factors including efficiency of the house and energy consumption. The largest answer was 6 to 10 years with second being 11 to 20 years. This indicates that many people feel that solar would take a significant amount of time to pay off, but should be achievable. However, if people think that the payback time is significantly lower than what it actually is, they may not be so inclined to purchase a system until it meets their expectations. There is a discrepancy between the 6% believing it will not pay itself off and the 10% who answered no in question #3. This may be caused by people skipping the question entirely, as the same number of people who answer yes in question #3 also answered somewhere within the timeline.



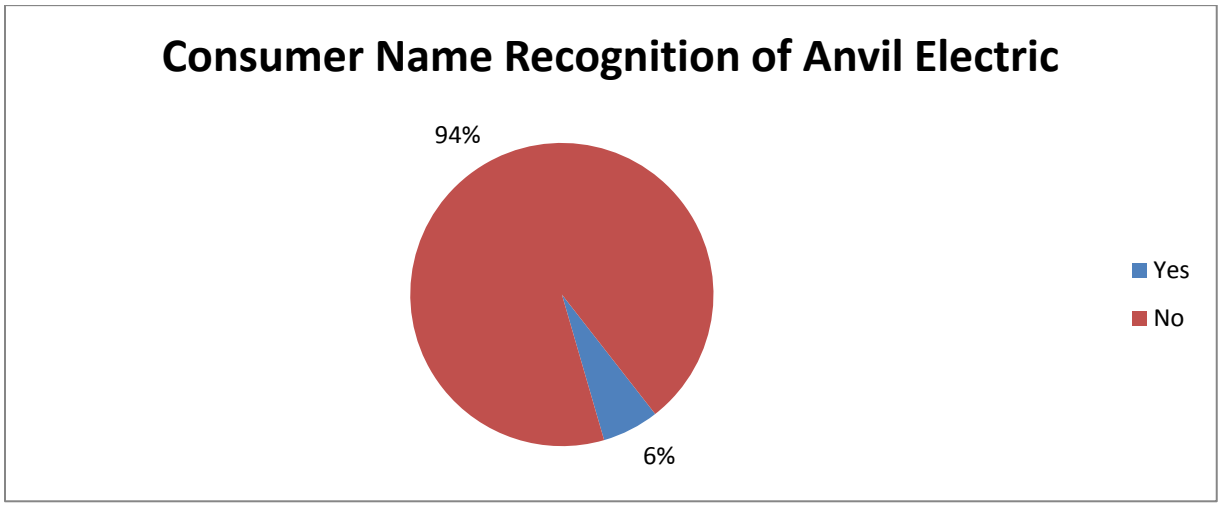

Question #5 asks when people would consider switching to solar energy. 35% of people would be thinking of switching to solar in less than 5 years, while 39% would be open to it eventually. This gives insight into how willing people could be to switch to solar in the area and what the market could be for a potential installer. A few people did mention that they had some confusion with this question, thinking that it was asking if they have considered switching to solar within the past 2 years, etc.



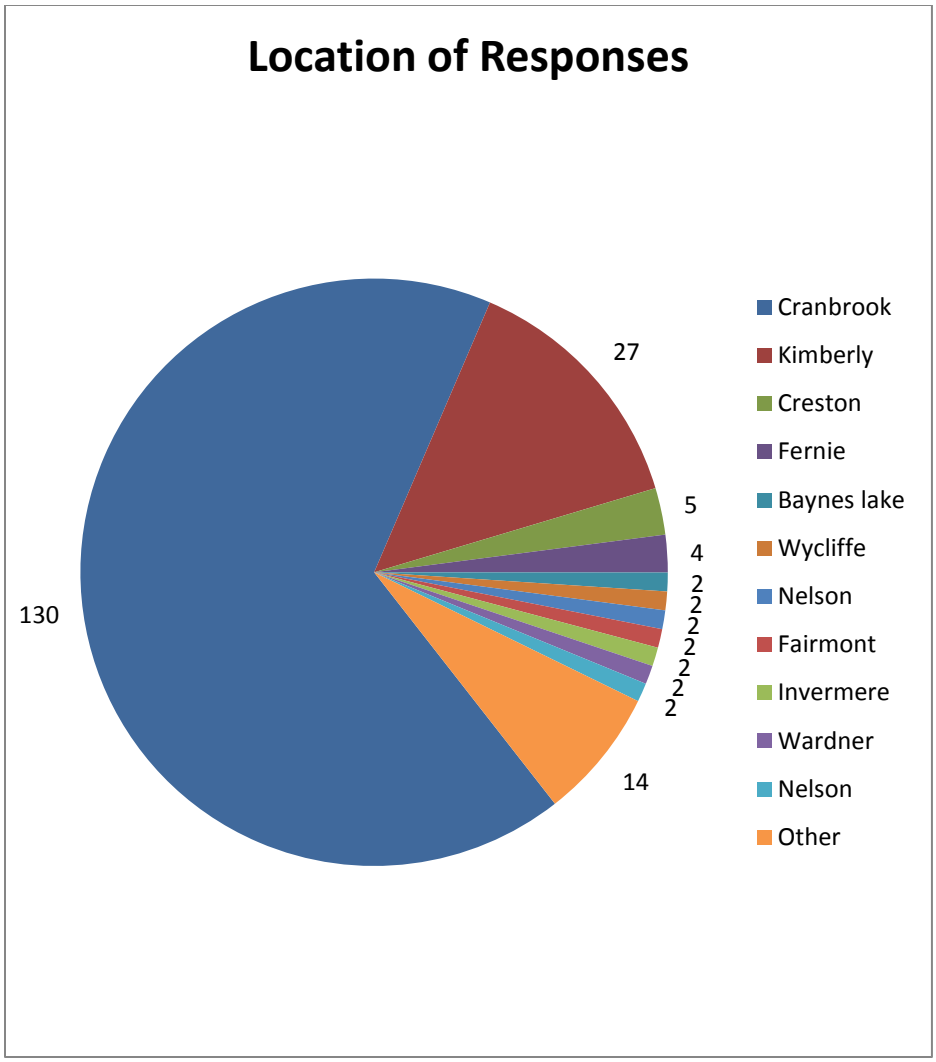

Question #6 looks at how much people would be willing to invest into a solar system. For the most part people would not want to spend a lot of money on an investment like this or none at all. Depending on the size of the house and the percentage of energy the person wanted to have from solar, the prices could be around $10,000 to $30,000 or more. This means that only about 11% would be willing to spend over $15,000. This might conflict with question #5 because people may be considering solar in the near future, but might not be aware of the price or have done little to no research on it.



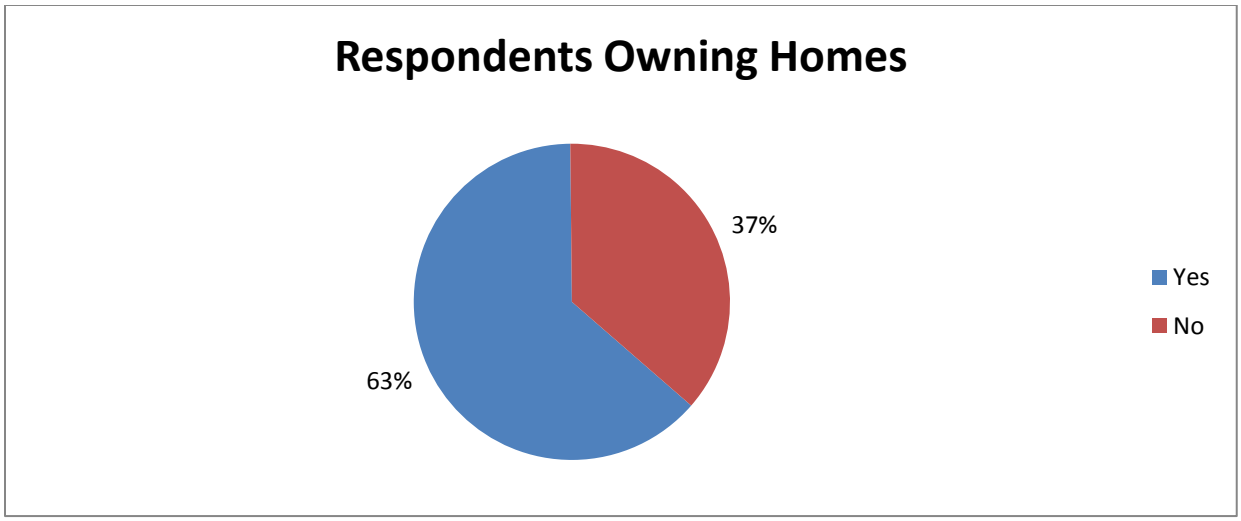

Question #7 asks the respondent if they would consider a solar system if it took 20 years for the system to payback its investment and the life of the equipment was expected to be around 30 years. This is down from the 74% of people who considered solar in question #5. There were several comments that said that this was quite a long time. However, it shows how people see the solar option if there is a clear payback that will happen within the life of the equipment. This question was made to help Anvil Electric understand the public's opinions a bit more.



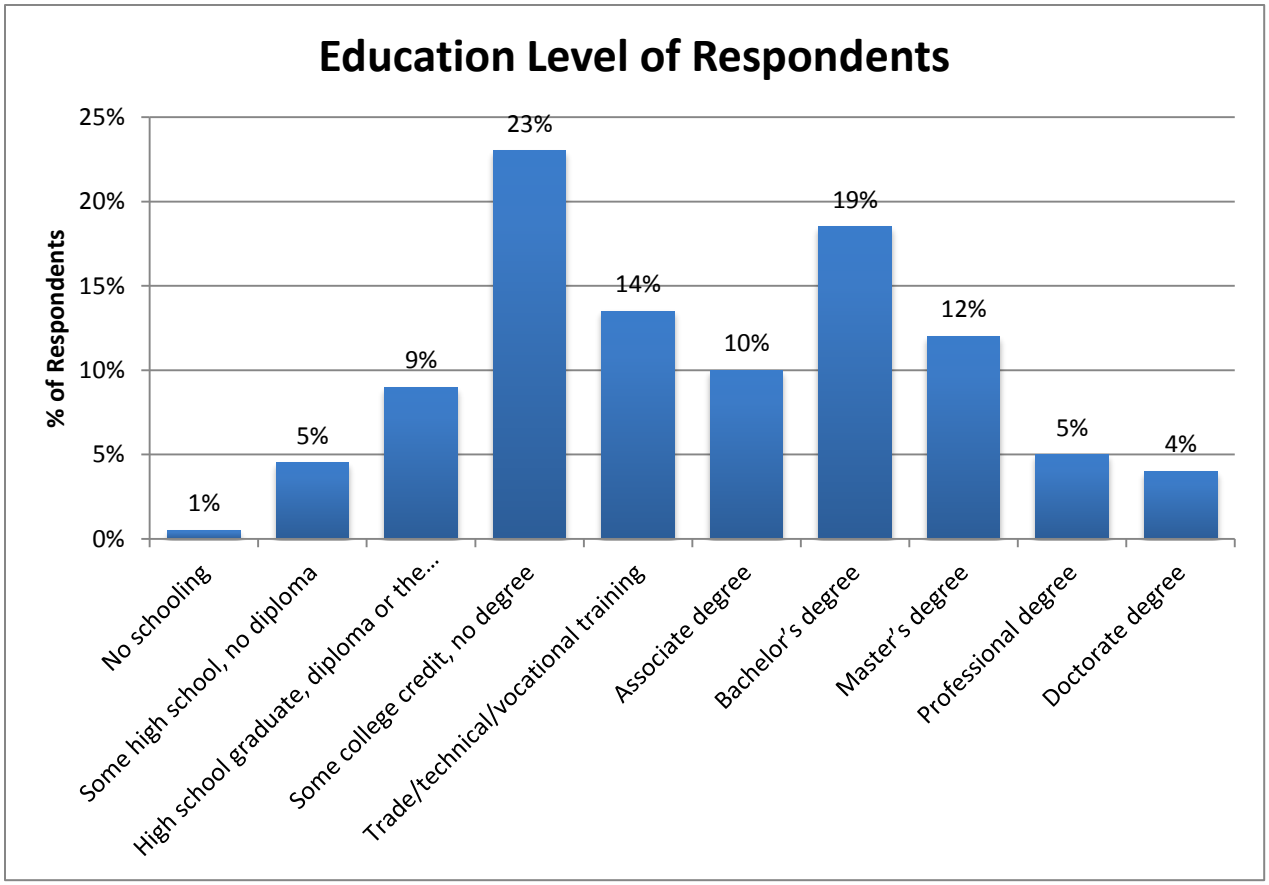

Question #8 is to see if consumers recognize the name Anvil Electric and can help give them a general idea of how aware people in the area are of them. This is mainly for use by the company itself.



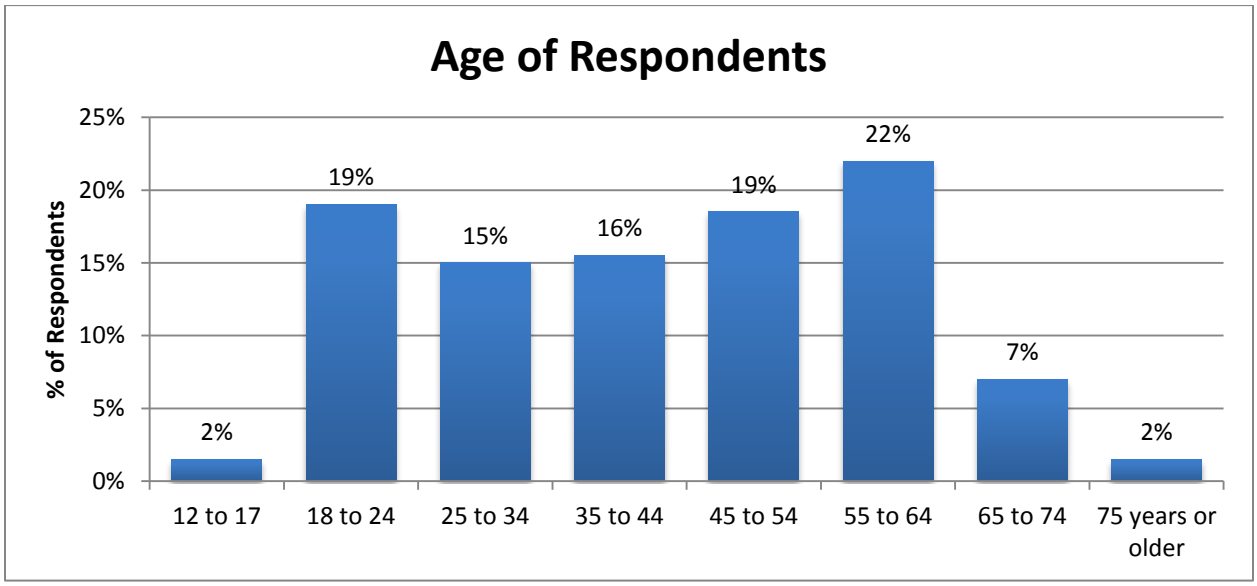

Question #9 is a demographic question to determine where the people answering the questionnaire are from. The majority of people were from the Cranbrook area, with Kimberley being in second. The other locations are named if there was more than one response, but there were fourteen others from various locations within the East Kootenays and outside of it. This shows that a large portion of the data is from the people who were desired to respond.




Question #10 determines if people own their own homes. This helps determine if people responding to the survey would be able to put a solar installation onto their homes without much trouble because they are the ones owning it. It shows that a majority owned their homes.



Question #11 categorizes the education level of the respondents. This is to show that the survey had a better representation of people with different educational backgrounds and helps remove a bias from one or more groups that could have occurred. However, many of the people who responded to the survey did have some sort of post-secondary education.

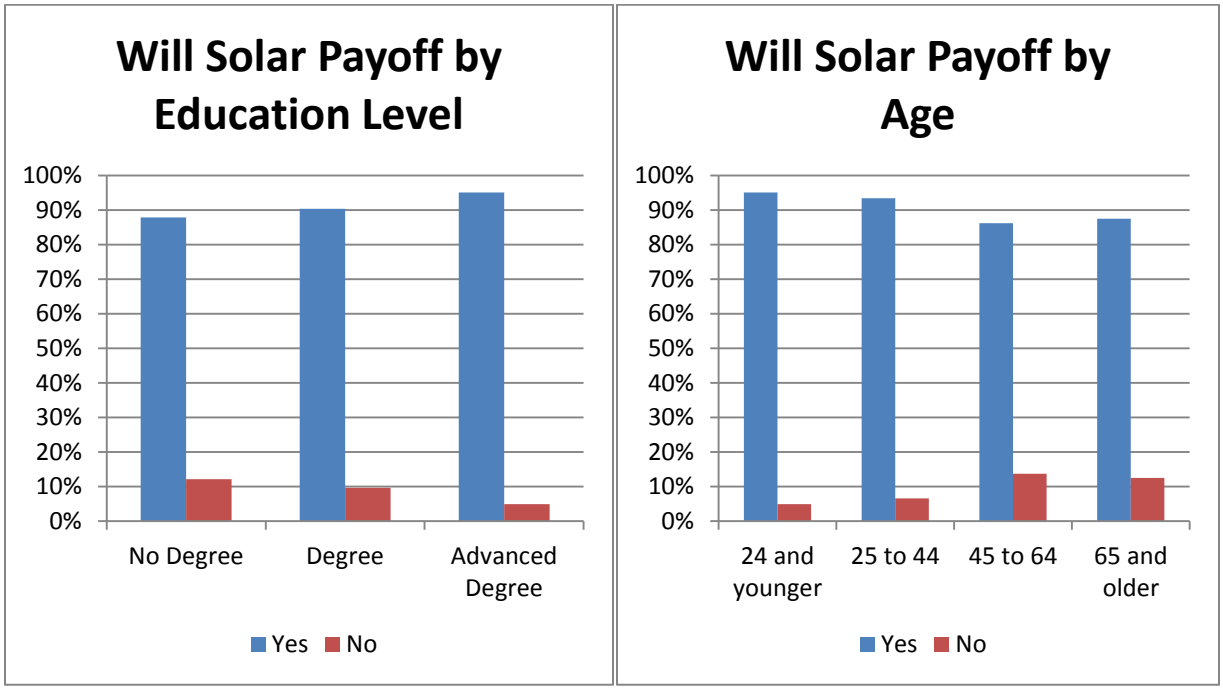



Question #12 is another demographics question to show that there was a good representation through most of the age groups and that the survey did not significantly favour any particular group. This is another question that helps to address any bias from the data collection in regards to age.

Overall the survey found out several opinions on what the general public thought about solar. This could be used to give a general idea as to how the area sees solar and what kind of market is out there for it. The survey had input from Anvil Electric to improve the survey form. There was a good amount of responses from the community; however, this research would be too small to be considered representative of the entire community, but is still a good generalization to work with.

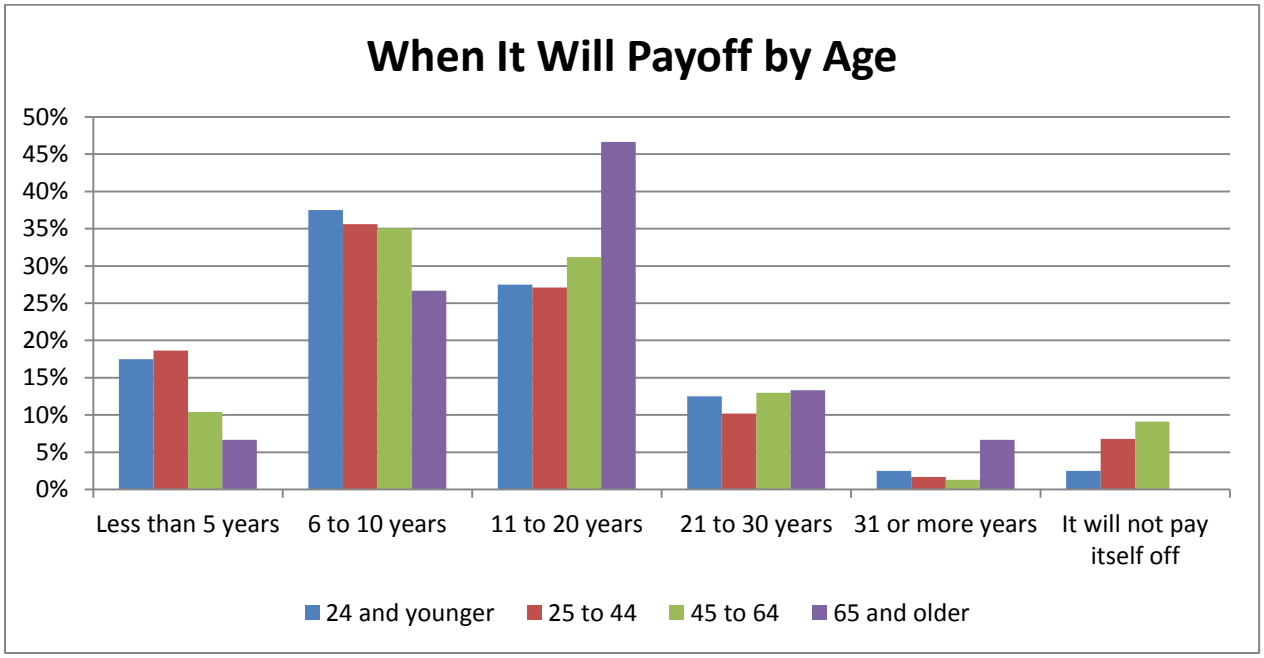
## Cross Tabulation of Survey

The survey data had a few demographic questions in it to help determine what profile groups were responding and if there was any significance. The main demographics looked at the differences between education levels, between age groups, and between people in Cranbrook or Kimberley. The education demographics were combined into three groups for easier analysis; no degree, which spans from a person having some college to no schooling; a Degree or some other technical training that is a bachelors or lower, but has some post-secondary credentials; or an advanced Degree, which is regarded as a masters or higher. The age range is condensed as well to make four groups; 24 and younger, 25 to 44, 45 to 64, and 65 and older. A note has to be made that the results should not be representative of specific groups in the area because the small sample size was broken down into even smaller groups, but it does offer a broad overview. There are several cross tabulations that were made in appendix V, however, a few interesting ones are analysed below.

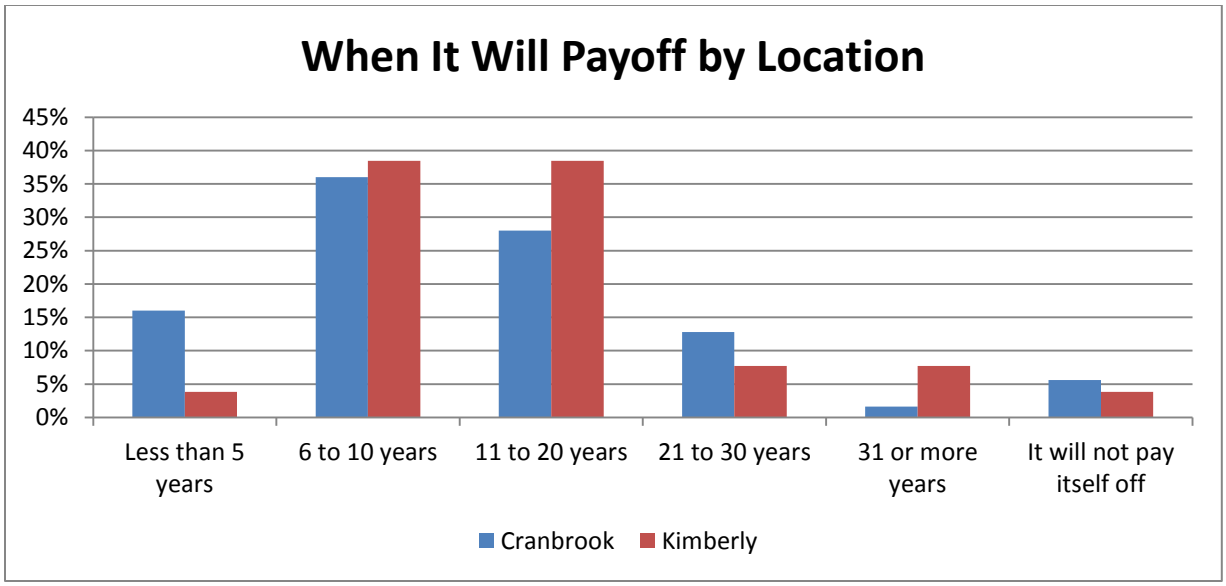



Using question #2 and cross tabulating it with the age and education demographics it shows a small trend. While the census agreeing that solar will pay itself off is quite high, there is still some movement.

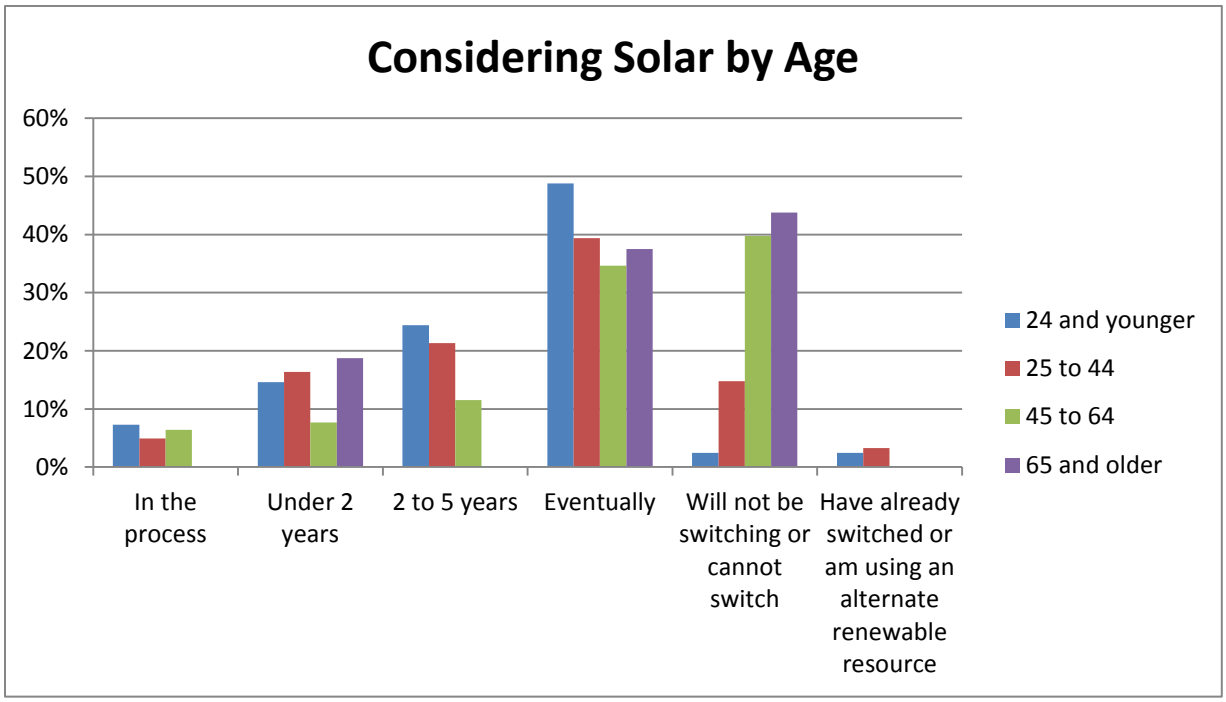
It could suggest that people with lower education levels might have a greater chance of thinking that solar would not pay itself off. However, it appears that some in older generations think that solar energy would not pay itself off. While these are very small fluctuations, it could show that there may be some disagreement with some individuals in older generations and those who have not had as much formal post-secondary education.



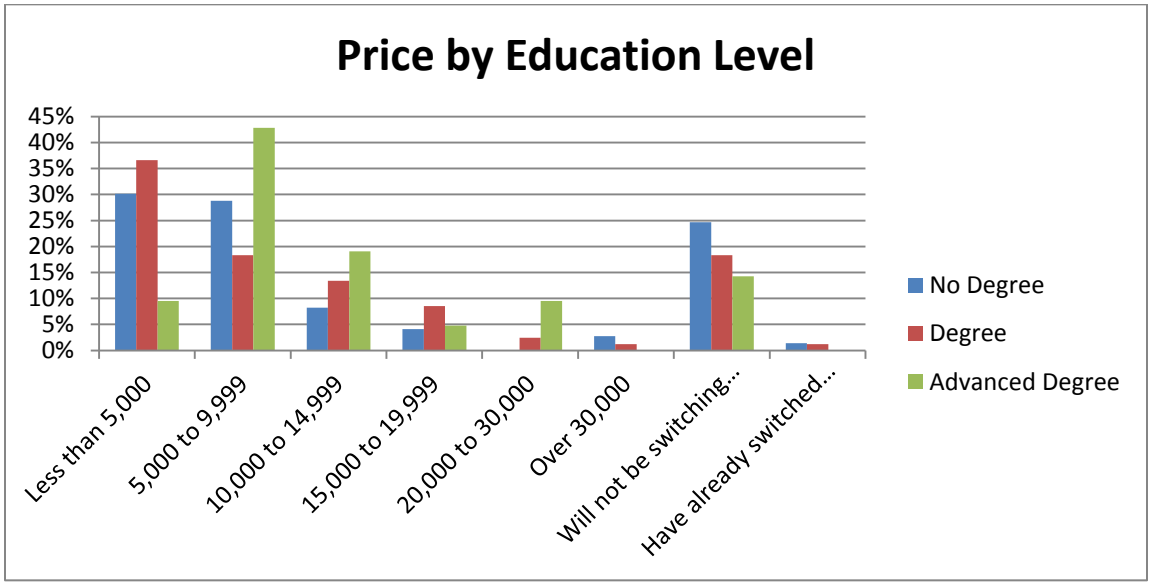

Question #4 is being crossed tabulated by age to show that younger generations and adult generations appear to think that solar might pay off quicker than it actually would. However, the older generations appear to have a longer term view of solar payback time which is close to what the current payback estimates are.



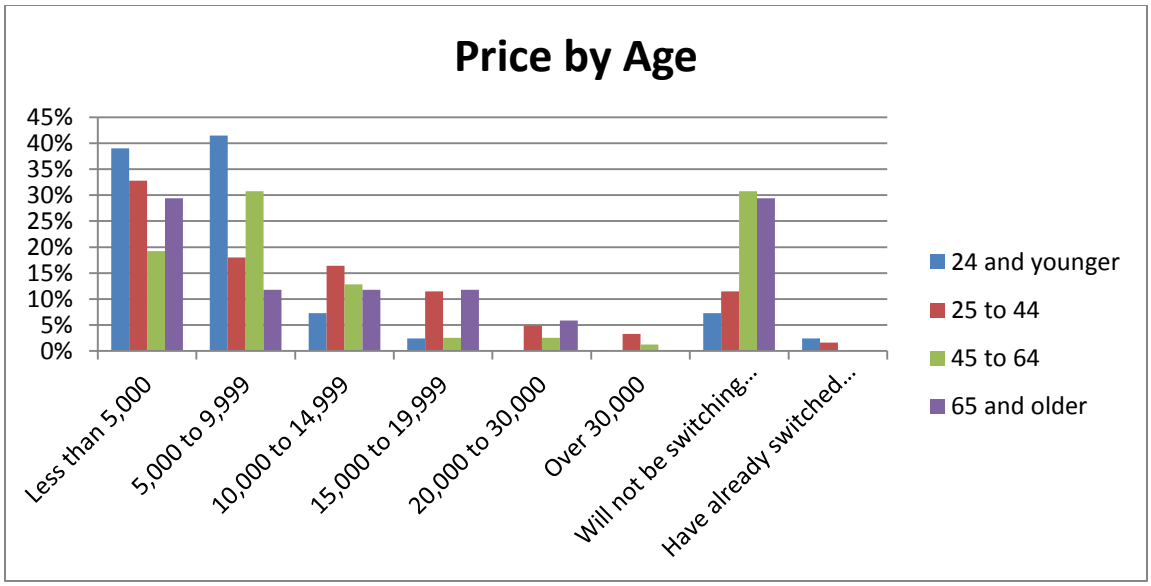

When looking at the responses to the payoff time by location it appears that there is a small difference. There are some in Kimberly who think solar will have a longer payoff. Some in Cranbrook could think it's a lot sooner and could be disappointed or discouraged if their estimates are wrong.



When looking at Question #5 cross tabulated with age it suggests that there is some differences between the younger generation and the older generations. Groups under 45 show more of an inclination to take on solar sometime in their life or near in the future. Older groups over 45 are split between doing it eventually as a possibility or knowing that they won't be in a position to switch. During the collection of the survey some people mentioned that they might not see the payback of solar within their lifetime and that was enough of a reason for them to not consider solar.

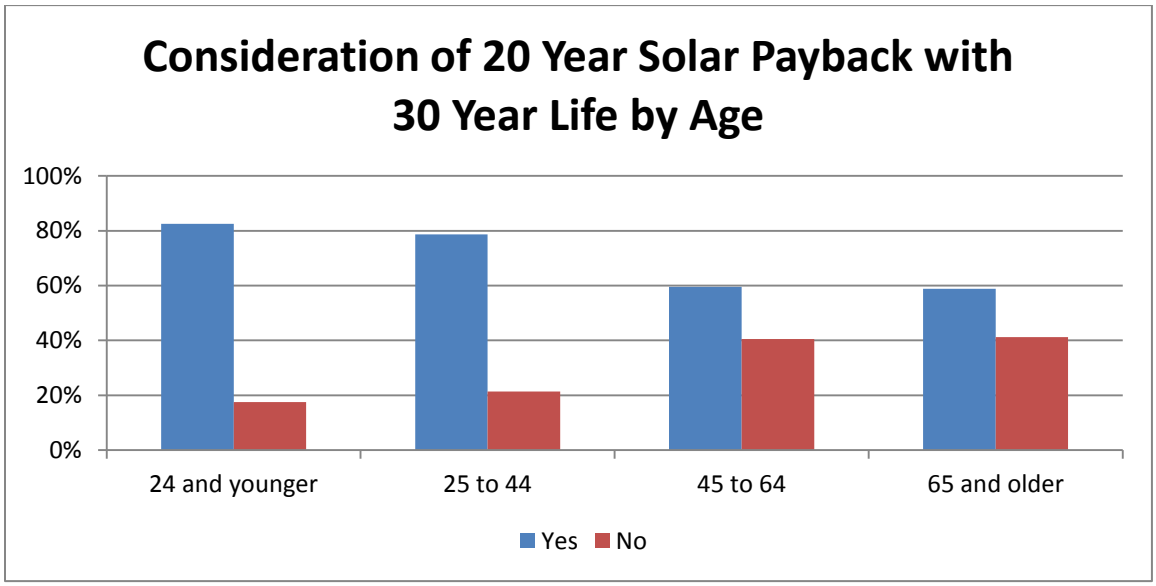



Question #6 is cross tabulated by education levels, age, and locations. With education levels it appears that those with a higher have either more money to put into an investment or more of a desire to go solar. The larger amount of money could be a factor from having higher paying jobs from a greater level of education. Those with lower to medium education levels are higher at the lower price amounts.




Price by age can suggest that the younger generations would generally invest less on a solar system compared to other, older age groups. This is interesting because they could be in the same group that considers solar the most, however, they might not be willing or able to make a large investment.

Price by location is another graph that has a few variations at different levels. Cranbrook has a slightly larger amount of people who would spend a lower amount. People from Kimberley appear to be more willing to spend within a middle amount. This might give an idea of where larger customers might be and how their perception of price may differ.




Cross tabulating Question #7 by age shows a more distinct trend line. Older generations appear to still not consider solar even if the payback is significantly shorter than the lifespan of the panels. Younger generations appear to be more confident with the arrangement and have a large chance of considering solar.

## Other Information

Looking at the BC Hydro net metering program, it is appropriate for commercial and residential customers to connect an electricity generating unit to the grid. There is a maximum of up to 100kW and does require that the energy is generated from a clean or renewable resource (BC Hydro, 2016). They require a smart meter to be installed to help determine energy use more efficiently (BC Hydro, 2016).

Annually, any excess generation credited on the account will be paid out at 9.99 cent per kWh. (BC Hydro, 2016).

BC Hydro's basic rates are two tiered. The first tier is "$0.0829 per kWh for first 1,350 kWh in an average two month billing period" while the second tier is $0.1243 per kWh over the 1,350 kWh threshold (BC Hydro, 2016). The average power usage for a residential customer is around 900kWh a month, or 1,800 every two months (BC Hydro, 2016). However, the rates applied to the power usage each month can vary wildly in different seasons, with winter bills that can be five to six times as much (BC Hydro, 2016). Using the data available it will cost the average house hold $1007.10 annually for electricity. These rates are scheduled to increase another "four per cent (fiscal 2017), 3.5 per cent (fiscal 2018) and three per cent (fiscal 2019)" with plans to have more increases in the second part of their 10-year plan (BC Hydro, 2016).

## Field-Research Overview

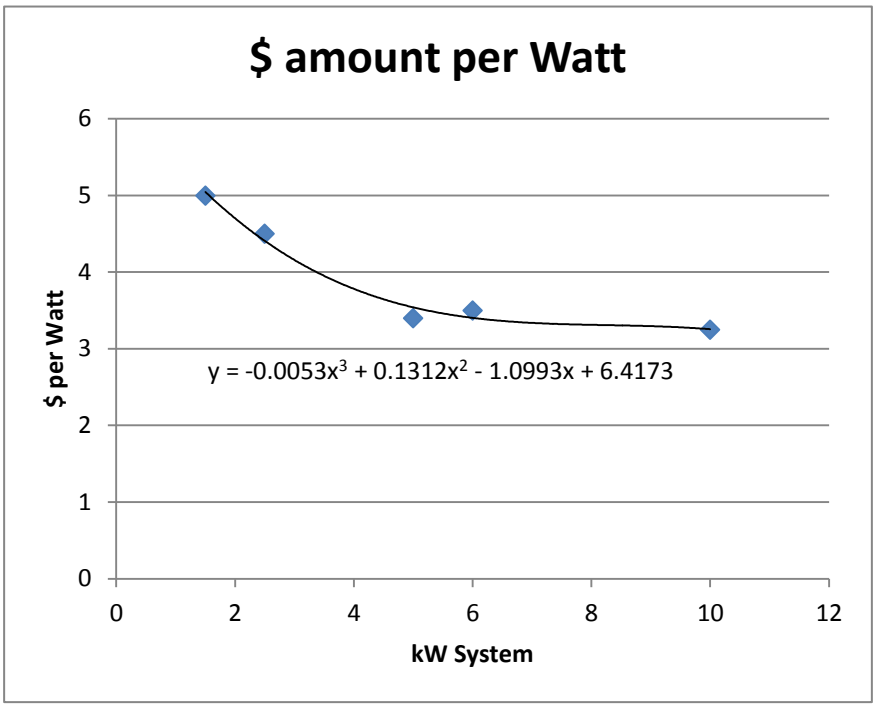
Overall the field research was generally successful. There was input from several people within the community who had experience with solar installing, had solar on their homes, or were involved in putting solar on a commercial building. This gave a wider view of the situation that solar is in right now in the Cranbrook area and brought out many insights that a regular person who switches to solar might want to know about.

### Research Limitations

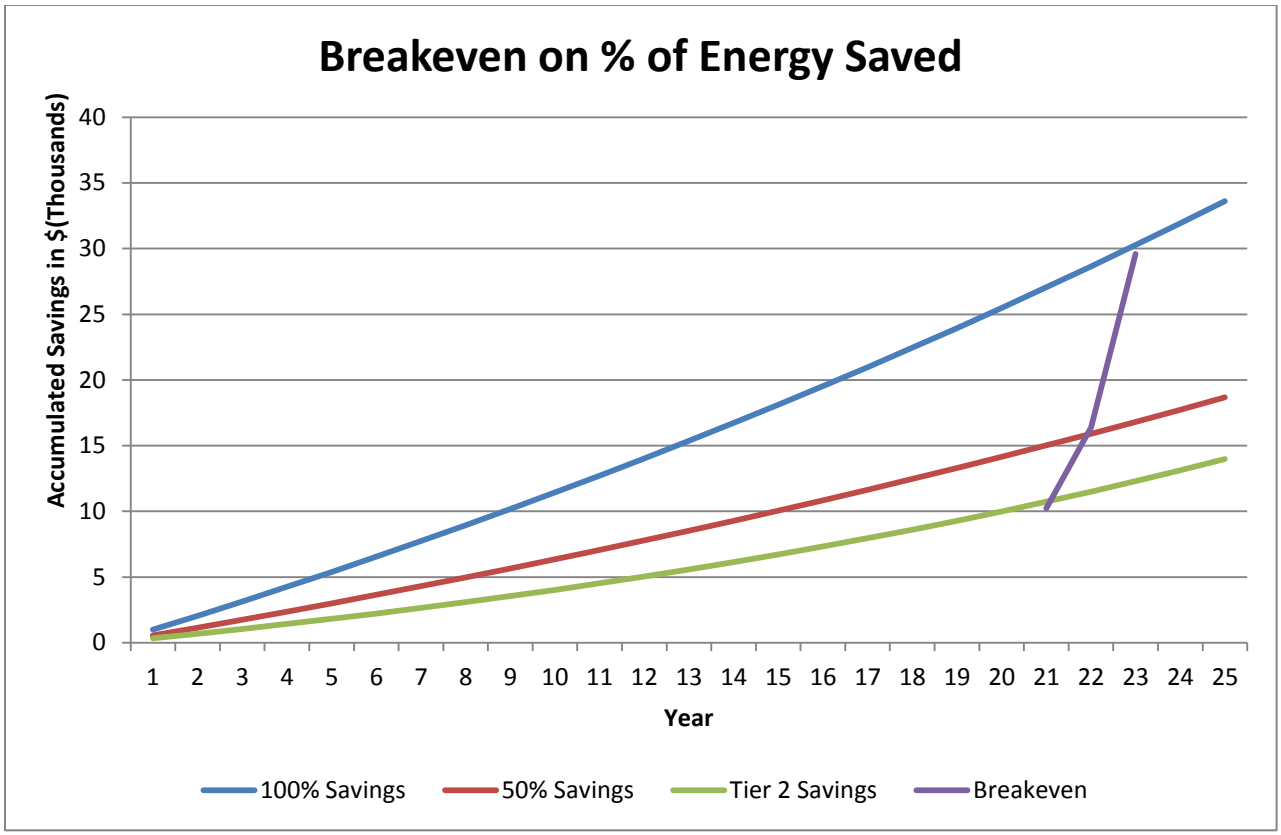
There were some issues and limitations to the plan that was developed for this project. The interview with Jori was from the perspective of someone who had significant experience with solar systems and who had put them on his house. While insightful, it didn't look at the perspective that a normal person may have been going through. The interview with Allan looked at a large commercial building and was out of the scope of the original plan. However, it did provide insight into how larger systems will cost less per Watt due to economies of scale. This shows how it would be better to buy in bulk and go for a bigger system if finances allowed for it. There was a plan to do two surveys; however, there were not enough people with solar systems to conduct a meaningful survey. The second survey was used instead and was well suited for research into the public opinion of solar.

## Evaluation

One of the important aspects of this research is if it is viable to consider solar power today in the Cranbrook area. With the data collected in the findings section, it is enough to calculate if it is financially sound to invest in solar. The average energy use for a residential home in BC is 10,800kWh annually, and the cost and payback time of going 100% solar will be determined. As previously stated, the average kWh/kW generated in the area is between 1,200 and 1,300, but for these calculations the number will be 1,200kWh/kW. This means that a 9kW system (10,800kWh/1,200kWh/kW) would have to be constructed. Using the $ amount per Watt pieces of data that were collected in the findings a graph was constructed to show a polynomial trend line to show the estimate cost per Watt when building a certain kW system. The calculations show that it would cost about $3.29/Watt for the 9kW system, or about $29,600 in total. The college's dollar amount per Watt was ommited because it was a larger commercial building that was outside the scope of these calculations.




Now examining the energy usage of an average household, the first 8,100kWh (1,350kWh * 6 two month billing periods) is applied at the $0.0829/kWh, while the other 2,700kWh is applied at the second tier price of $0.1243, and together they equal a base energy expense for a home to be $1007.10. Since BC Hydro is planning an increase in their rates for several years their future rate increases of 4%, 3.5%, and 3% were included in the calculations, along with an estimated expected rate increase of 2% in all other years to account for price changed in the future. The time it would take for the savings to add up was put into the graph below; break even points were determined for different percentages of household energy being on solar.




| Breakeven Year | System Size | Output | Purchase Price |
|---|---|---|---|
| 21 | 2.25kW | 2,700kWh | $ 10,200 |
| 22 | 4.5kW | 5,400kWh | $ 16,400 |
| 23 | 9kW | 10,800kWh | $ 29,600 |

Sourcing 100% of energy requirements from solar power is indicated by the top blue line and shows that it would take 23 years to break even on the investment. A breakeven point in this range is very good because the payback time is within the estimated life of 30 or more years that solar panels may run for; not including long warranties that may be included. Because of the tiered system, it would be slightly more financially efficient to purchase a system that could eliminate the annual 2,700kWh that an average household uses and pays for in the second tier rate. Also, it would require a significantly smaller investment initially and could be a good entry to solar. Overall, yes, it is financially viable to switch to

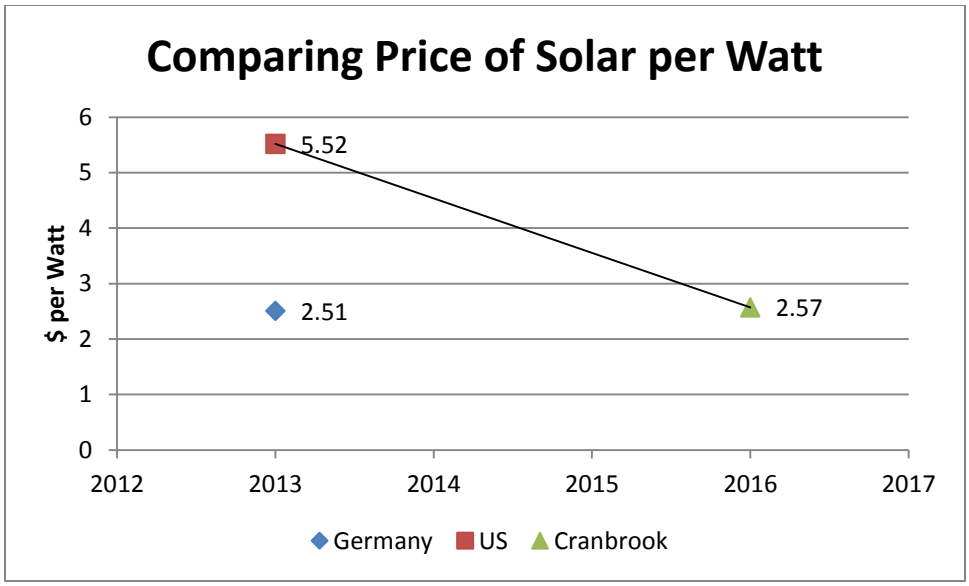
solar, and if energy rates rise higher than forecasted, the years it will take to return on the investment will be reduced.

## Discussion

The literature review helped develop a preliminary understanding for what type of solar system would be investigated during the research; the result was choosing to focus on the on-grid solar PV systems. This was in part due to its flexibility in accessing electricity in suboptimal conditions such as poor weather or at night.

Comparing other places in the world is necessary to have an idea of what environmental situation Cranbrook naturally has. Several places in the Kootenays and a place like Germany had less kWh being produced annually for a 1kW sized system. They are compared in the chart. For cities west of Cranbrook the output is lower by around 7%, while in Germany it is around 30% lower. However, these numbers are only an average and will fluctuate from year to year.

| Location | Output |
|---|---|
| **Cranbrook** | 1,200kWh – 1,300kWh |
| **Castlegar** | 1,110kWh |
| **Nelson** | 1,113kWh |
| **Trail** | 1,120kWh |
| **Berlin, Germany** | 848kWh |




The price of solar has also changed through the years when compared to different places. For this data the price for solar in an average home costing $3.29/Watt in CAD will be changed to USD to work with data from other countries. Using the exchange rate on June 10th, 2016, of 1CAD to 0.78USD, the cost is calculated at $2.57/Watt. From the chart above, it shows that the cost to install solar has gone down to match the cost in Germany in 2013; which, as previously stated, Germany has around 50% of the world's installed solar systems. It shows that the Canadian price dropped 53% compared to the median price in the US in 2013. This indicates that the price of solar has been decreasing over time even more and the Cranbrook area could start to increase amount of solar systems to compare to the amount Germany has.

One thing to note is that with Question #1 in the survey, there was a significant portion of respondents who thought that the major electrical source in the area was from fossil fuels. While hydroelectric already is a renewable resource, people may think there is more of a need in the area for solar energy.

This could be due to the thought that if fossil fuels are a majority energy source in the area, solar panels would be a better alternative.

## Recommendations

There are several things to understand when investing into a solar system. Planning the system is an important aspect that should be given consideration and deciding why to switch to solar is equally important. It is essentially clean and free energy once the solar panels are installed and operating. There are even bigger incentives to switch that can be seen in the recent 24% price increases in energy costs from BC Hydro for the next four years. There may be some doubts to switching to solar panels; however, there are many other options to help live a more sustainable lifestyle. For people looking for energy savings as a key reason to get solar, it would be prudent to minimize energy use and go after some low hanging fruit first before considering solar; changing the lighting into LED or CFL bulbs, putting in more insulation, getting more energy efficient appliances. This is easier and less of an investment and a great starting point for someone who wants to be more energy conscious. To help fund a solar project like this, one can look at specific green loans that are offered from banks like Toronto Dominion. Although, a person should not be focused on a large system if they are not financially ready for it and opt instead to go with what they can afford.  For an initial investment into solar it could be wise to start with a smaller system that covers the amount of electricity that is being charged in BC Hydro's second tier rates. If someone is planning to go even bigger and reap bigger savings, the best approach would be to build from the ground up to create an overall more efficient household.

The ideal place for a solar system would be somewhere where the view of the sun to the south, east, and west is uninterrupted. The solar system should be approved by the local government and a net metering program set up through BC Hydro. Creating an on-grid system avoids batteries and allows energy to be used in the home like normal; even at night or on days when it's cloudy. To limit the amount of surprises that can arise from a solar project like this, it can be extremely beneficial to have experienced contractors involved in the construction. This brings their knowledge and expertise into the project, and helps avoid costly do-it-yourself trial and errors.

Generally there is no or very low maintenance for the solar panels. They only require a small bit of dusting off or shovelling snow a few times a year. Also, it would be important to have a monitoring system set up so that if there are any faulty panels or electrical components, an alert will be sent. This can be done through an online user interface to access metrics tracking energy production. However, if one was willing and able to adjust the angle the solar installation was tilted at, the production of energy could be increased through tilting it at various angles through the year. It would be better to have a tilt at latitude +15 during the winter and -15 during the summer, while transition months at March and September are better when the tilt is at latitude.

Another important consideration is the environmental concerns that happen through manufacturing and disposal of solar units. If improperly handled, PV cells made with cadmium have the potential to seep into the ground and into ground water, and be a damaging carcinogenic. This can be mitigated with a strong recycling program to resolve any environmental concerns when the solar panels are disposed of at the expected end of life or if damaged. There is a reminder that there are some environmentally harmful processes that do go into manufacturing solar panels such as caustic chemicals, use of precious

metals, and potentially the water used and electricity generated at specific sources. Examining what company the solar panels are sourced from can help find a panel that is more sustainable than others.

The recommendations for this research are to serve as a general guide for getting a solar system. It is targeted towards a person in the Cranbrook area. The data from the survey questions helps build a profile for what people might be looking for. From respondents, 35% were thinking of switching to solar in the next 5 years. This would be a good target audience for these recommendations as the data is current and could help them in making an informed decision. Many of the respondents either think or want solar to pay itself off within 20 years, so picking the installation that has a better return on investment would be ideal for them. However, the difference between the return on investment for a smaller system and a larger system is only a few years and it might not make too much difference if it would take two more years to pay off the larger installation. Pricing is a very important factor with the solar installations. Through analyzing how much people would invest, it showed that the majority prefer a lower cost option. It would be recommended for this group to choose a smaller solar installation that covers the amount of energy used in their second tier. The investment needed for an average home in BC, covering its second tier energy use would be around $10,000. This would allow them to make a smaller investment, while still getting some benefits of solar.

## Conclusions

Overall this report was able to find that solar in the Cranbrook area is financially viable and appears to be getting better as time goes on. The stories, successes and challenges of people who have solar systems or who work with solar systems have been analysed and designed into a guide for people who

consider switching. While the need for solar energy might not be directly evident in BC because of the extensive amount of hydroelectric, this is an opportune area to have a beneficial environmental impact. A movement like this starts in one area then builds to more and more over time, and having an increase in renewable resources could give additional incentives for others to do the same. It would be environmentally beneficial to have energy generation incorporated into already built human constructions, avoiding the need to displace people and carve out plots of land from the environment like hydroelectric has done. For future research, a study should be done to see how people might be more inclined to adopt solar and how it can be brought into the communities more.

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## Appendix I - Survey #1 - People who switched to solar

This research survey is being conducted by Kyler Robertson, a BBA student and the College of the Rockies in Cranbrook and is to help determine how your experience had been in switching to solar power and if it is feasible for others to do so. This should only take 15 minutes to complete and will require information from an electrical bill PRIOR to when you installer your solar system and information AFTER you installed your solar system. The information you provide will be anonymous and only used for the research, but you are free to opt out from the survey at any time. If the questionnaire is completed it is assumed that consent has been given. If you have any questions or concerns regarding this project please contact the researcher Kyler Robertson at KRobertson587@hotmail.com or the faculty supervisor for this project Greg McCallum at gmccallum@cotr.bc.ca.

1) Are you; (Please select all that apply)
    a. A homeowner with a solar energy system
    b. Owner of a business with a physical building that has a solar energy system
    c. Not a homeowner or business owner with a solar energy system

2) What town do you live in/ are near to
    a. Cranbrook
    b. Other _____

3) Who installed your solar energy system?
    a. X
    b. Y
    c. Z
    d. Other _____
    e. I did it myself

4) What was the total cost of purchasing and installing your solar energy system?

    (Dollar amount) _____

5) How satisfied were you with your solar installer
    a. Very Satisfied
    b. Satisfied
    c. Neither Satisfied nor Unsatisfied
    d. Unsatisfied
    e. Very Unsatisfied

6) Based on a previous electrical bill PRIOR to installing your solar energy system, how much electricity did you use in kWh?

_____kWh

7) Based on electrical information AFTER installing your solar energy system, how much electricity did you use in kWh?
(Preferably in same month as in #6. Eg. October 2014 and 2015)

_____kWh

8) What percent of your total power is solar generated? _____ %

If you are interested in having a short 30min interview with the researcher Kyler Robertson and discussing your experiences in more detail. Please contact the research directly through KRobertson587@hotmail.com or through your solar installer.

## Appendix II - Survey #2 - General feelings and beliefs about solar

This research survey is being conducted by Kyler Robertson, a BBA student and the College of the Rockies in Cranbrook and is determining peoples' feelings and beliefs about solar energy in the Cranbrook. This should only take 15 minutes to complete. The information you provide will be anonymous and only used for the research, but you are free to opt out from the survey at any time. The results of this survey and other research will be presented at the College of the Rockies in spring 2016. If the questionnaire is completed it is assumed that consent has been given. If you have any questions or concerns regarding this project please contact the researcher Kyler Robertson at KRobertson587@hotmail.com or the faculty supervisor for this project Greg McCallum at gmccallum@cotr.bc.ca.

1) Where do you think the majority of energy to power your home comes from?
    a. Solar
    b. Wind
    c. Geothermal
    d. Hydroelectric
    e. Fossil Fuels
    f. Bio-Fuels

2) Rate how many sunny days do you think Cranbrook has in a year compared to other parts of North America and Europe?

Very Low Low Average High Very High

3) Do you feel that converting to solar will pay itself off?
   a. Yes
   b. No

4) If you said yes to Question #3, when do you think it will pay itself off?
   a. Less than 5 years
   b. 6 to 10 years
   c. 11 to 20 years
   d. 21 to 30 years
   e. 31 or more years
   f. It will not pay itself off

5) If you have considered switching to solar, when have you considered it?
   a. In the process
   b. Under 2 years
   c. 2 to 5 years
   d. Eventually
   e. Will not be switching or cannot switch
   f. Have already switched or am using an alternate renewable resource

6) If you have considered switching to solar, how much would you invest into a solar system?
   a. Less than 5,000
   b. 5,000-9,999
   c. 10,000-14,999
   d. 15,000-19,999
   e. 20,000-30,000
   f. Over 30,000
   g. Will not be switching or cannot switch
   h. Have already switched or am using an alternate renewable resource

7) Would you consider an installation if you expected a pay back in 20 years and expected the equipment to last for 20 to 30 years.
    a. yes
    b. no

8) Have you heard about these solar installers? (Check all that apply)
    a. X
    b. Y
    c. Z
    d. I have not heard of any of these

9) What city do you live in?
    a. Cranbrook
    b. Kimberly
    c. Other

10) Do you own your own home?
    a. Yes
    b. No

11) What is your current education level?
    a. No schooling
    b. Some high school, no diploma
    c. High school graduate, diploma or the equivalent (for example: GED)
    d. Some college credit, no degree
    e. Trade/technical/vocational training
    f. Associate degree
    g. Bachelor's degree
    h. Master's degree
    i. Professional degree
    j. Doctorate degree
    k. Other _____

12) What is your age?
    a. Under 12 years old
    b. 12-17 years old
    c. 18-24 years old
    d. 25-34 years old
    e. 35-44 years old
    f. 45-54 years old
    g. 55-64 years old
    h. 65-74 years old
    i. 75 years or older

## Appendix III - Interview

-What has been the biggest benefit to going solar?

-What are some of the biggest challenges?

-Why did you choose solar energy?

-What were your biggest concerns going into the solar project?

-Where there any surprises that happened along the way?

-Are there any changes into your day to day activities? E.g has to check on it, don't have to pay electrical?

-Would you do it again or recommend someone else convert?

-What would you recommend for someone who was going to convert to solar?

## Appendix IV - Personal Interview Consent Form

Solar energy in the Cranbrook area

You are being invited to participate in interview on your experiences in getting a solar system put into your home or business. This will be used to compare the feelings and beliefs of people who have not switched, with your actual experiences.

This interview will require about 30 minutes of your time. It will be conducted at an agreed upon location. It will be recorded by audio preferably unless you choose to opt out, along with notes being taken by the research at the time of the interview. You have the option to edit and approve the interview notes prior to them being inserted into the report.

Your anonymity will be protected as only the solar installer and researcher will know that you participated. Only the researcher will know what you said and any information you provided. The typed up results from this interview will not contain any mention of your name or any other identifying information and use code number instead. The audio recordings and notes will be destroyed upon completion of this project.

Your participation is completely voluntary and if you decide to withdraw from the interview, you can do so at any time for any reason. If you do, all of the information from the interview will be destroyed. The results of the research as a whole will be presented to the College of the Rockies in 2016. The researcher reserves the right to publish or have commercialized benefits from this research. Your name and any other personally identifying information will not be disclosed or at any point in time during this.

If you wish you may be able to get the results of the research project through the researcher or your solar system provider. The researcher is Kyler Robertson, a BBA student from the College of the Rockies in Cranbrook and can be reached at KRobertson587@hotmail.com. The faculty supervisor is Greg McCallum and can be contacted at 250-489-2751 ext.3623 or at gmccallum@cotr.bc.ca. Any questions can be answered by the researcher before proceeding.

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I have read (or have been read) the above information regarding this study on your experiences on switching to solar power, and consent to participate in this study.

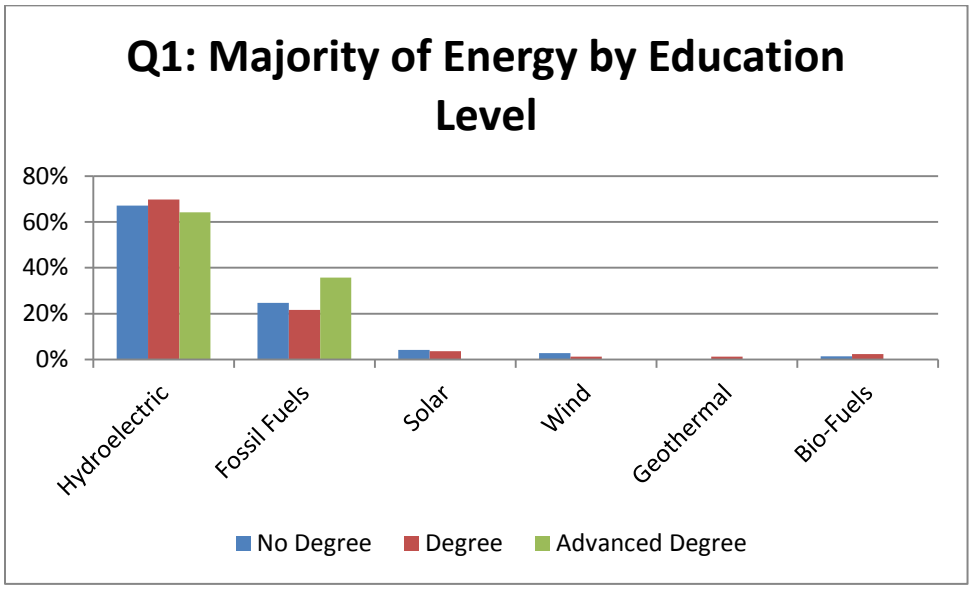
_____ (Printed Name)

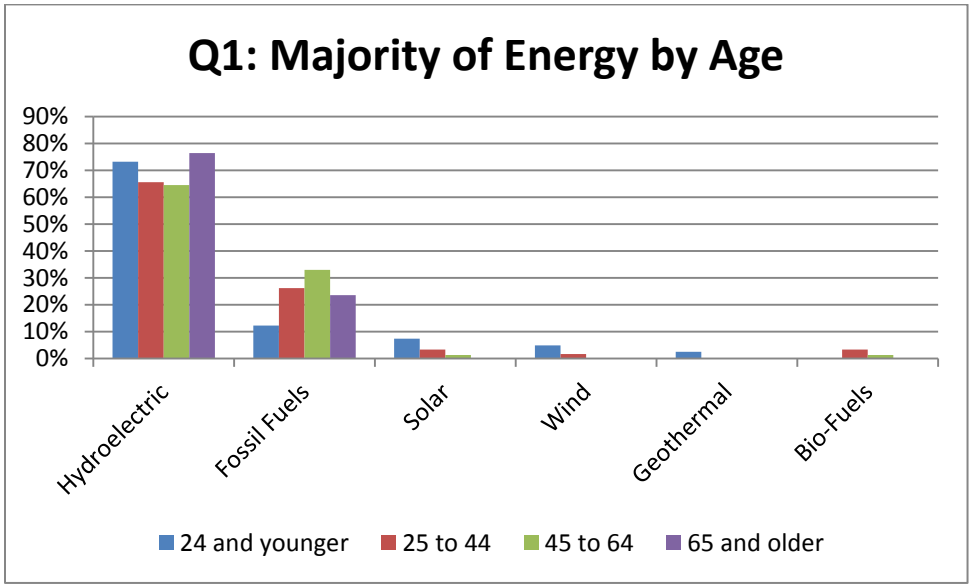
_____ (Signature)

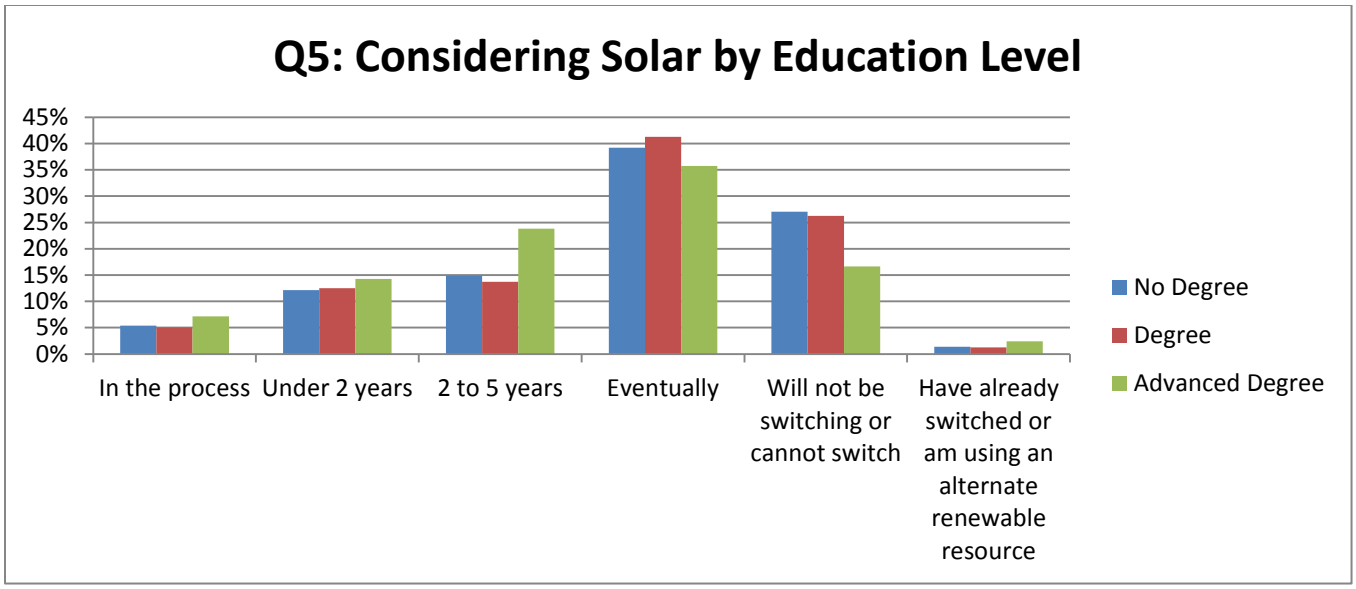
_____ (Date)

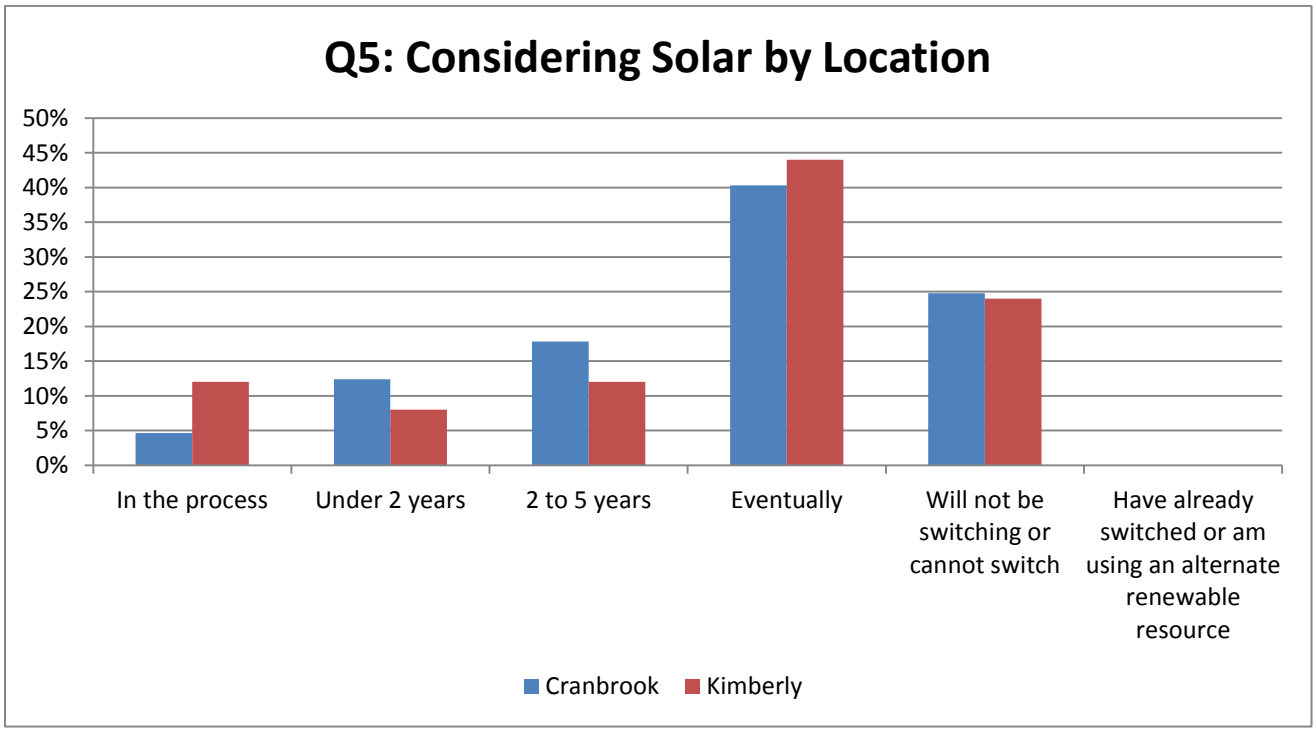
I consent to having an audio recording of the interview (Initials) _____

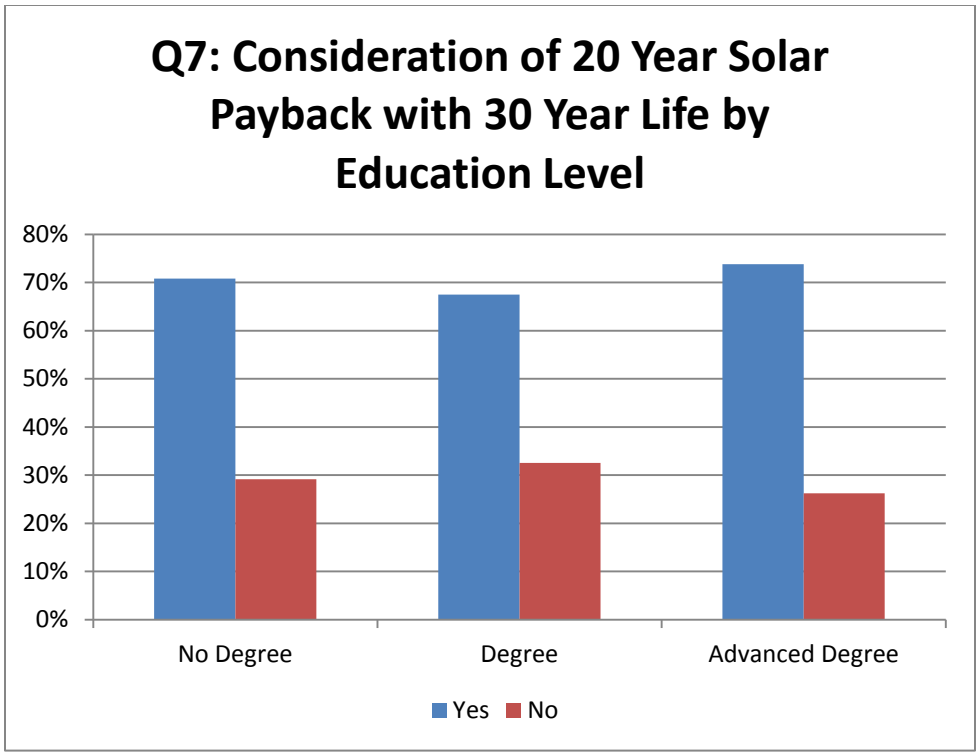
## Appendix V – Extra Cross Tabulations




Q5: Considering Solar by Education Level
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
In the process
Under 2 years
2 to 5 years
Eventually
Will not be switching or cannot switch
Have already switched or am using an alternate renewable resource
No Degree
Degree
Advanced Degree


Q5: Considering Solar by Location
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
In the process
Under 2 years
2 to 5 years
Eventually
Will not be switching or cannot switch
Have already switched or am using an alternate renewable resource
Cranbrook
Kimberly


Q7: Consideration of 20 Year Solar Payback with 30 Year Life by Education Level
80%
70%
60%
50%
40%
30%
20%
10%
0%
No Degree
Degree
Advanced Degree
Yes
No